OCTOBER, 1955
No. 209

ASTM Bulletin

1955-1956 TECHNICAL PUBLICATION SCHEDULE

American Society for Testing Materials

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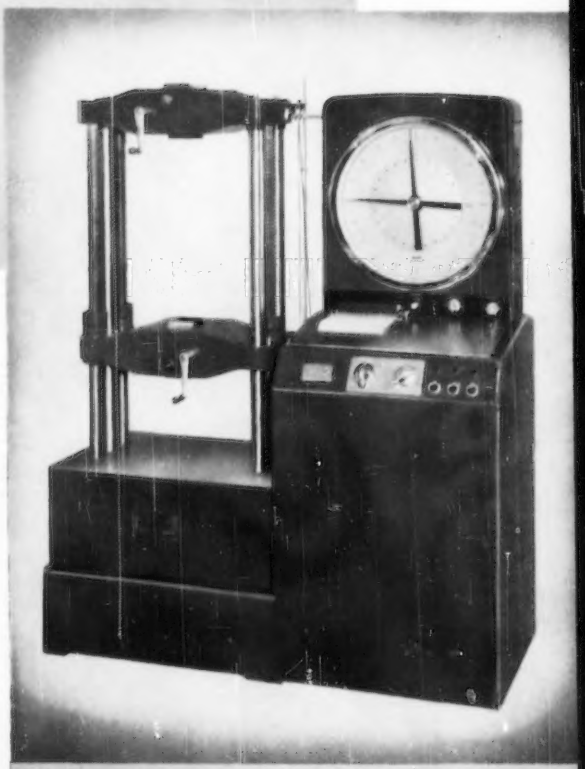

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ASTM BULLETIN

OCTOBER 1955

Number 209

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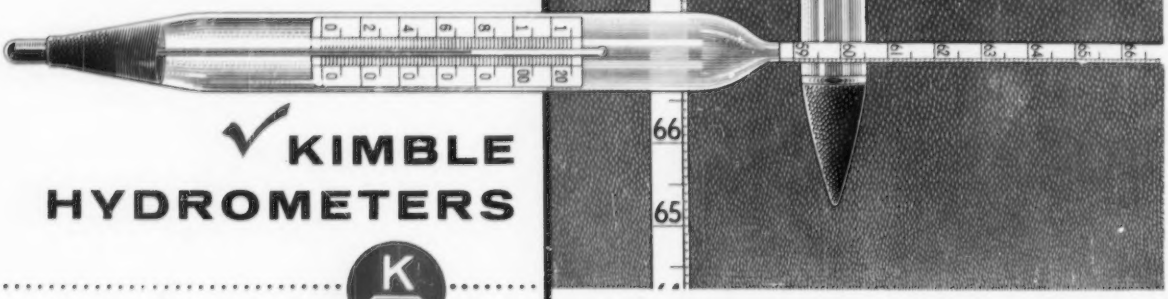

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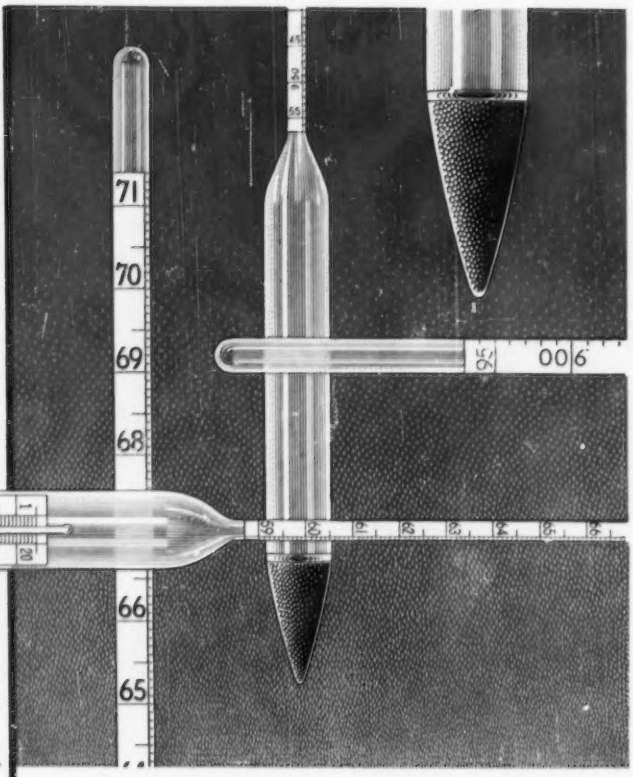

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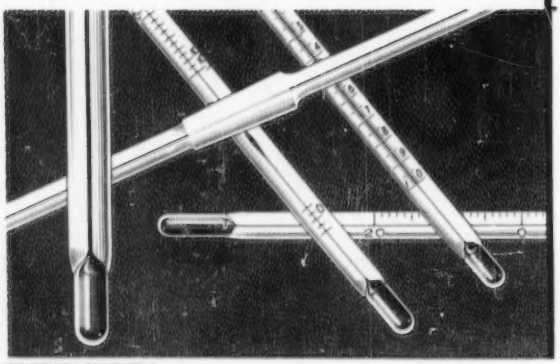

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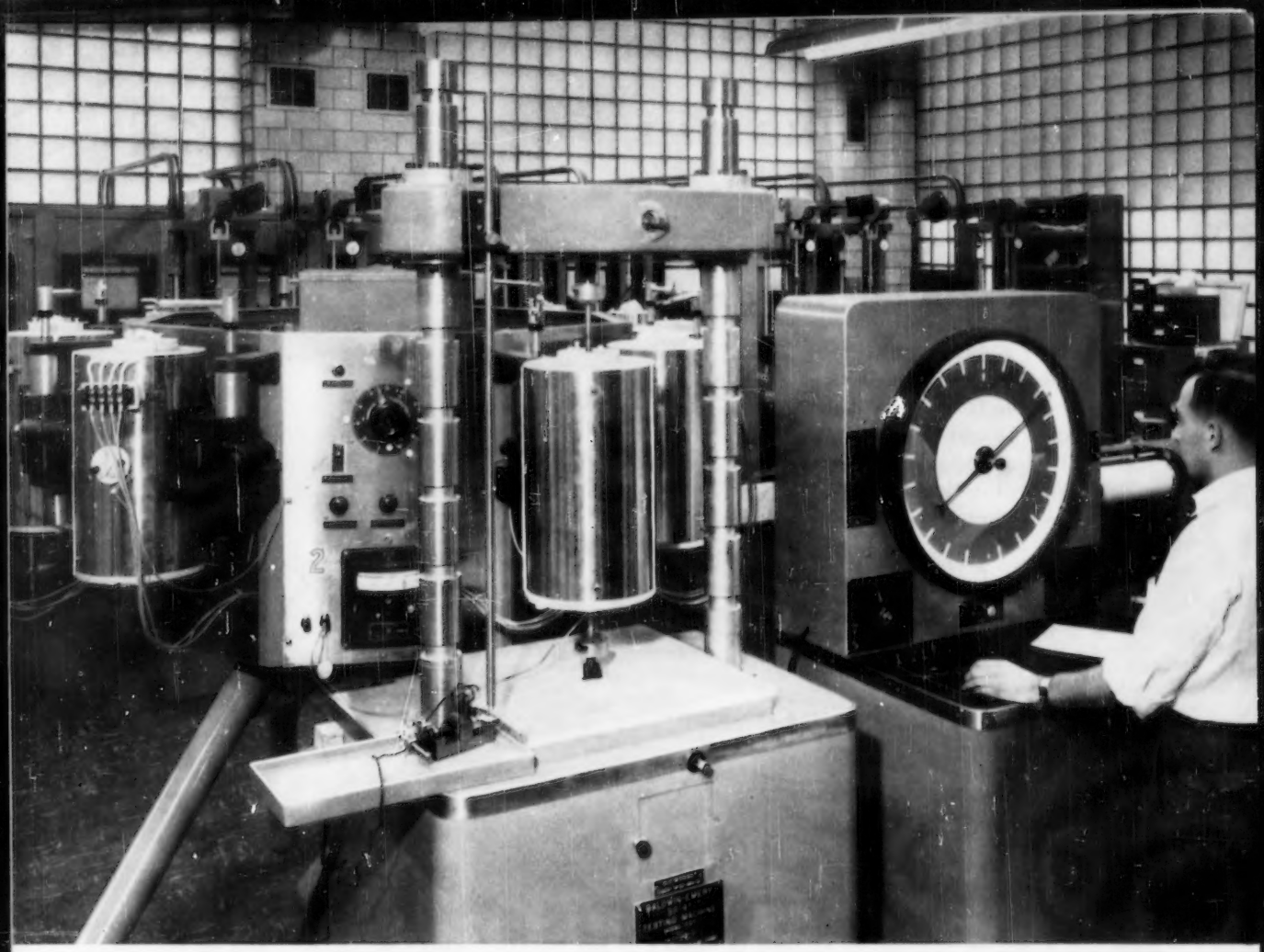

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ASTM BULLETIN

"Promotion of Knowledge of Materials of Engineering, and Standardization of Specifications and Methods of Testing"

Number 209 October, 1955

ASTM's Publication Schedule

Appearance of Seven-Part Book of Standards Tops 1955–56 Program

VARIOUS reviews and statements are presented from time to time covering specific areas of the Society's work—news concerning committee activities, standardization developments, etc. Possibly no summary or statement is more effective than one covering the publications that are forthcoming, for these represent the results and crystallization of these other activities.

The publication schedule of the Society continues to grow as is evidenced by the number of books scheduled to appear in the coming year. The special technical publications which include symposiums and numerous papers are advancing that phase of the Society's work concerned with the promotion of the knowledge of materials. The big 1955 Book of ASTM Standards and the special compilations of related standards reflect the growth in work and the concentration on the Society's second objective—standardization of specifications and tests. Members will be posted on the appearance of these publications and will be furnished with convenient blanks to procure them. On almost all, special prices to members are in effect.

REGULAR PUBLICATIONS

1955 Book of ASTM Standards

Possibly the most important and certainly the biggest publication now in hand is the seven-part 1955 edition of the Book of ASTM Standards. This edition will total almost 12,000 pages, 17 per cent larger than the 1952 edition. Following previous practice, the seven volumes will be published as a grouping together of separate compilations. The books will be printed on a Bible-type paper but the stock will be somewhat more substantial and yet will bulk little more than did that used in the 1952 book. The seven parts are:

1—*Ferrous Metals*
2—*Non-Ferrous Metals*
3—*Cement, Concrete, Ceramics, Thermal Insulation, Road Materials, Soils*
4—*Paint, Naval Stores, Wood, Cellulose, Wax Polishes, Sandwich and Building Constructions, Fire Tests*
5—*Fuels, Petroleum, Aromatic Hydrocarbons, Engine Antifreezes*
6—*Plastics, Electrical Insulation, Rubber, Electronics*
7—*Textiles, Soap, Water, Paper, Adhesives, Shipping Containers, Atmospheric Analysis*

All the books are scheduled to appear during the next few months, starting with Part 1 which is now available.

1955 Index to ASTM Standards

This Index, which continues to increase in value as the number of published ASTM standards becomes larger, provides the latest complete reference to the publications in which the various specifications and test methods appear. Publication of the new edition is scheduled for February.

Special Compilations of Standards

The tabulation given below of special compilations of standards should be viewed as approximate only. There are so many factors affecting these books that it is not possible to give any accurate estimate of size or the date that they may become available. The size is affected by committee recommendations which may be submitted through the Administrative Committee on Standards, and the date of issue is governed somewhat by editorial considerations and the appearance of the Book of Standards, and also to a great extent by the tremendous publication load at the printers.

Sponsoring Committee	Title	Approximate Number of Pages	Approximate Appearance Date
A-1	Steel Piping Materials	376	October
B-1	Wire for Electrical Conductors	290	December-January
B-5	Copper and Copper Alloys	610	December
B-7	Light Metals and Alloys	224	December
B-8	Electrodeposited Metallic Coatings	100	September
C-1	Cement	280	October
D-2	Petroleum Products and Lubricants	1016	November
D-4, D-8	Bituminous Materials for Highway Construction, Waterproofing and Roofing	448	November
D-6, D-10	Paper, Paper Products, and Shipping Containers	390	October
D-11	Rubber and Rubber-Like Products	710	March
D-12	Soaps and Other Detergents	180	October
D-13	Textile Materials	760	January
D-20	Plastics	770	October

1955 Proceedings

The 1955 *Proceedings*, to be issued in March, will contain about 1400 pages of technical papers and discussion presented at the 1955 Annual Meeting. The discussions comprise a most significant and technically valuable feature. The *Proceedings* also contains all reports submitted by the Society's technical committees during the current year. Both the Marburg and Gillett Lectures (see page 8) appear in the *Proceedings* although also issued as separate reprints.

The papers and discussions presented at the Annual Meeting as part of special symposiums will appear separately in special technical publications and are described more fully below.

1955 Year Book

The Year Book, which is now available, contains a list of the complete membership and official company-member representatives (name, title, address, company, etc.), personnel of all ASTM committees, as well as other useful information about the Society. It is furnished to members free of charge on request and may be purchased by committee members.

SPECIAL TECHNICAL PUBLICATIONS

The following symposiums featured as part of the 1955 Annual Meeting will be published separately with discussion:

Impact Testing
High Purity Water Corrosion
Atmospheric Corrosion of Non-Ferrous Metals
Metallic Materials for Service at Temperatures Above 1600 F
Panel on Pyrometry

Symposium on Impact Testing (STP 176)

This symposium was sponsored by the Impact Committee of Committee E-1 on Methods of Testing in recognition of the need for development of more fundamental information with respect to the test. The last Impact Symposium was held in 1938 and much technical development since that time has been attributed to information contained in those symposium papers. Now, seventeen years later, another Impact Symposium steps into a field that is already brimming with interest and activity. Some phases of this field carry the designation "environmental testing."

Along this line, it was suggested that papers on shock tests be included in this symposium which encompasses impact in parts, components, and complete structures, and does not confine the symposium to notched-bar testing. This broadened scope was undertaken with what appears to be a very beneficial enhancement of the practical application of the impact test and of testing at high straining rates. Several papers, however, are devoted to the discussion of notched-bar testing in order to lay the groundwork for subsequent discussions. The following papers will appear in the symposium volume:

Notched-Bar Testing—Theory and Practice
Transition Behavior in V-Notch Charpy Slow Bend and Impact Tests
Reproducibility of Charpy Impact Testing
Automatic Impact Testing to −236 C
The Influence of Pendulum Flexibilities on Impact Energy Measurements
The Impact Tube: A New Experimental Technique for Applying Impulse Loads
Longitudinal Impact Tests of Long Bars with a Slingshot Machine
Shock Tester for Shipping Containers
Properties of Concrete at High Rates of Loading

This publication is scheduled to appear late this year or early next.

Symposium on High Purity Water (STP 179)

The timeliness of this symposium is revealed in the fact that high-purity water is of particular importance in nuclear reactor systems and much of the material presented in this symposium deals directly with such systems. This symposium is of outstanding significance both in the operation of the conventional high-temperature, high-pressure generators and also in connection with the operation of nuclear reactors.

Methods of preparing and maintaining high-purity water are covered in a paper in which the author discusses such points as purification of the water by ion exchange, the effect of oxygen in the water on corrosion, a testing program for development of materials of high-temperature use in high-purity water, and methods of analysis for metal ions and corrosion products.

The effect of material composition on corrosion in high-purity water at high temperatures is covered in two of the papers. While high-alloy steels and other special corrosion-resistant alloys were found to exhibit high corrosion resistance, it is pointed out that there is evidence that carbon steel may have adequate corrosion resistance for many applications using high-purity water, including nuclear reactor systems.

Another paper discusses the effect of water composition on corrosion in high-temperature, high-purity water, and the authors point out that the effect of water composition on the nature or behavior of corrosion products may, in some instances, be of greater importance than its effect on corrosion.

The water requirements of various parts of atomic reactor cooling systems, for reactors for power sources as well as for reactors for nonpower applications are covered in one of the papers in which the authors discuss the possible sources of radioactivity in the system, means of minimizing activity due to impurities in the water by efficient removal of them, proper selection of materials of construction, etc.

This symposium should be available in November.

Symposium on Atmospheric Corrosion of Non-Ferrous Metals (STP 175)

The authors of the papers comprising this symposium are combining reports of their own private work on the atmospheric corrosion of non-ferrous metals and that of Subcommittees VI and VIII of ASTM Committee B-3 on Corrosion of Non-Ferrous Metals and Alloys. It is their expectation that the information obtained in the 20-year exposure of various non-ferrous metals and alloys and the recently completed tests of galvanic couples, combined with the private work reported, will be useful in the proper selection of materials for atmospheric exposure.

At the 1946 ASTM Spring Meeting the results of the first ten years of the Subcommittee VI tests were described in a symposium which the present symposium supplements by adding the work indicated above, the results of private investigations, and the present viewpoints of the authors whose experience has been greatly extended during the intervening years.

In the paper "The Resistance of Aluminum-Base Alloys to 20-Year Atmospheric Exposure" the authors conclude that in all environments the rate of attack on aluminum alloys, especially penetration of attack, decreases markedly with time.

In "Effect of Marine and Urban Atmospheres on Aluminum Alloys" the authors point out that aluminum alloys containing magnesium, manganese or cadmium, or clad alloys containing copper were the most corrosion resistant aluminum alloys in urban and marine atmospheres while an alloy containing copper, manganese, and silicon was the least resistant.

The author of the paper "Effect of Natural Atmospheres on Copper Alloys—20 Year Test" reports that the ef-

fect of pitting was negligible, and, in general, corrosion rates were highest in industrial atmospheres, averaging less than 0.1 mil per year; in rural atmospheres averaging less than 0.025 mil per year.

In a similar paper entitled "Atmospheric Corrosion of Copper—Results of 20 Year Test" the author describes the effect of atmospheric corrosion on eleven brands of copper in sheet and wire form exposed at four Connecticut locations. It was found that the purest copper corroded least and arsenical copper the most. The difference is not believed to be of practical significance.

Two papers deal with galvanic corrosion tests sponsored by Committee B-3. In "Atmospheric Galvanic Corrosion of Dissimilar Metal Couple" the author discusses the results to date of the disk-type phase of the magnesium couple program initiated in 1949. In the second paper, "Galvanic Couple Corrosion Studies by Means of the Threaded Spool and Wire Test," the author describes the bolt and wire type couple program which has been completed.

Both the earlier 10-yr results and the present 20-yr results are presented in the paper, "The Atmospheric Corrosion of Rolled Zinc." The author indicates that the corrosion rate of zinc is lowest in dry, pure atmospheres and highest in industrial atmospheres. In "The Behavior of Lead, Tin, and Antimonial Lead in the Outdoor Atmosphere," the authors indicate that the tests on lead show this material to be very durable at all the test sites. In industrial and sea coast exposures, tin is less corrosion resistant.

In the last paper "Atmospheric Corrosion Behavior of Some Nickel Alloys," the author concludes that nickel and high-nickel alloys are very resistant to corrosion at marine and rural locations. In severe industrial locations the corrosion is more pronounced.

This symposium is scheduled for publication late this fall.

Symposium on Metallic Materials for Service at Temperatures Above 1600 F (STP 174)

The pressing demand of engineers to attain greater efficiency in heat engines has created a need for metals to withstand increased operation temperatures. Steam power plant design engineers are pushing temperatures and operating pressures beyond the safe operating limits of the ferritic steels now in use, and the gas turbine engineers—not to mention those concerned with such devices as guided missiles—are prepared to design for operation at temperatures higher than the 1600 F limit to which they have been confined for want of materials capable of withstanding higher temperatures.

What the prospects are for providing metallic materials suitable for such service furnishes the subject matter of this symposium which was sponsored by the Research Panel of the Joint ASTM-ASME Committee on Effect of Temperatures on Properties of Metals.

The papers comprising the symposium are as follows:

Some Sheet and Bucket Materials for Jet Engine Application at 1600 F and Higher
Influence of Boron on Cast Cobalt-Base S-816 Alloy
The Effect of Heat Treatment and Structure Upon Creep Properties of Nimonic Alloys Between 750 and 950 C
Stress-Rupture Properties of Inconel 700 and Correlation on the Basis of Several Time-Temperature Parameters
Chromium-Nickel Alloys for High-Temperature Application
Effect of Rare Earth Additions on the High-Temperature Properties of a Cobalt-Base Alloy
Creep Rupture and Notch Sensitivity Properties of S-816 Alloy up to 1650 F Under Various Combinations of Fatigue and Static Stress
Titanium-Carbide Base Cermets for High-Temperature Service
Titanium-Carbide Products Produced by Infiltration Technique
High-Temperature Properties of Molybdenum-Rich Alloy Compositions Made by Powder Metallurgy
Tension and Torsion Tests on Nimonic Alloys at High Temperatures
Thermal Fatigue Testing of Sheet Metal
The Development of Zirconium-Rich Protective Coatings and Brazing Materials for Heat-Resisting Alloys

This very interesting and timely symposium which attracted a large audience at the time of its presentation at the Annual Meeting will be available in November.

Panel on Pyrometry

At the Annual Meeting, a panel session on pyrometric practice in elevated temperature testing was held. The resulting publication will include the paper "Some Sources of Error in Temperature Measurement Arising from Thermocouple 'Immersion' Effects" by J. M. Berry and D. L. Martin, several prepared discussions, and the discussions that took place at the time of the meeting. The panel was sponsored by the Joint ASTM-ASME Committee on the Effects of Temperature on the Properties of Metal and was organized by the Test Methods Panel.

The primary reason for holding this panel and publishing the material is a problem which has existed for some time with respect to the test practices published by ASTM on elevated temperature tension tests, short-time tests, long-time tests, and rupture tests. These methods are designated as E 21, E 22, and E 85 and have stood for some time. Much interest centers on the definition of the precision of temperature measurement and control which can be recommended or specified in high-temperature test work.

In their paper, Messrs. Berry and Martin discuss two types of "immersion errors." The first type occurs when an inhomogeneous portion of a thermocouple is subjected to a temperature gradient; the second type of "immersion error" is related to conduction of heat to or from the hot junction of thermocouple. To resolve the problem partially the authors suggest that it may be well to stabilize thermocouple materials prior to their use or possibly to detect the change in the emf temperature relationship by recalibration.

This publication is scheduled to be available in November.

Symposium on Basic Effects of Environment on the Strength, Scaling, and Embrittlement of Metals at High Temperatures (STP 171)

Since most of the creep and creep-rupture tests from which design data on high-temperature alloys can be obtained are carried out in normal atmospheres and since most high-temperature

OFFERS OF PAPERS FOR 1956

THE Administrative Committee on Papers and Publications will meet early in February to consider the papers to be published by the Society in 1956 and to develop the program for the Annual Meeting which will be held in Atlantic City, N. J., June 17 to 22.

All those who wish to offer papers for presentation at the meeting and publication by the Society should send these offers to Headquarters *not later than January 10, 1955*. Offer forms are also available to those interested in submitting papers for presentation at the September 1956 Pacific Coast meeting.

All offers should be accompanied by a summary which will make clear the intended scope of the paper and will indicate features of the work that will, in the author's opinion, justify its publication and inclusion in the Annual Meeting program.

Suitable blanks for use in transmitting this information will be sent promptly upon request to Headquarters.

materials are used in atmospheres of water vapor or some products of combustion, the design engineer must always be concerned with the effects of the environment upon the creep rate and the ductility of the material that he uses. It was with the hope of contributing to the understanding of these effects that the General Research Panel of the ASTM-ASME Joint Committee on Effect of Temperature on the Properties of Metals decided to sponsor this symposium. It was felt that there must be data on oxidation and surface effects and on creep under controlled atmospheres that the panel could collect in one publication and that by so doing, further work in this field would be stimulated.

There are six papers with discussion on oxidation and surface effects comprising this symposium volume, and it is felt that this symposium represents rather accurately the status of the problem of environment at the present time.

• **This publication is now available.** Copies can be obtained from ASTM Headquarters, 1916 Race St., Philadelphia, Pa. Price: $2.75; to members, $2.

Report on the Elevated Temperature Properties of Carbon Steels (STP 180)

This is one of a series of reports prepared under the auspices of the Data and Publications Panel of the ASTM-ASME Joint Committee on Effect of Temperature on the Properties of Metals. Other reports in this series have covered the austenitic stainless steels (*STP 124*), the chromium-molybdenum steels (*STP 151*), selected super-strength alloys (*STP 160*) and copper-base alloys (*STP 181*—currently in course of preparation). Other reports scheduled for the near future will include relaxation properties of metals at elevated temperatures, the elevated-temperature properties of weldments, the elevated-temperature properties of medium- and high-carbon alloy steels, and the elevated-temperature properties of high-chromium stainless steels.

This report is a graphical summary of the elevated-temperature strength data for carbon steels. It includes summary curves for tensile strength; 0.2 per cent offset yield strength; per cent elongation and reduction of area; stresses for rupture in 100, 1000, 10,000, and 100,000 hr and stresses for creep rates of 0.0001 and 0.00001 per cent per hr (1 per cent in 10,000 and 100,000 hr). The primary sources of data for the report were the laboratories engaged in the evaluation of metals for elevated-temperature service. However to make this report more complete, data have been taken from the trade bulletins and the published technical literature. Data sheets have been prepared from the data taken from these sources and are included with the data sheets contributed by the cooperating laboratories. The source of the data is given on each data sheet.

• **This publication is now available.** Copies can be obtained from ASTM Headquarters, 1916 Race St., Philadelphia, Pa. Price: 75 cents; to members, 65 cents.

Marburg Lecture

The Marburg Lecture originated as a memorial to the first Secretary of the Society and was established to emphasize the importance of furthering knowledge of properties and tests of engineering materials. At the 1955 Annual Meeting, the 29th Edgar Marburg Lecture entitled "A Technology for the Analysis, Design, and Use of Textile Structures as Engineering Materials" was presented by Walter J. Hamburger who is Director of Fabric Research Laboratories, Inc. and a well-known textile scientist.

Dr. Hamburger traces textile craftsmanship from its beginnings in antiquity through the industrial revolution to the present, with particular emphasis on the last decade. It was only a decade ago that Harold DeWitt Smith presented the classic 19th Marburg Lecture on "Textile Fibers—An Engineering Approach to Their Properties and Their Utilization," which together with the work of F. T. Peirce in England, established the basis for modern textile science and consideration of textiles as engineering materials. Dr. Hamburger amplifies and brings up to date the engineering design concepts for textiles expressed by Smith and Peirce.

In the lecture, Dr. Hamburger examines the newest techniques and equipment employed in the analysis of textiles, mentioning the behavior of textiles in tension, compression, bending, and torsion. Also discussed are the effects of structural order upon the physical properties of fiber, the effects of fiber properties upon yarn behavior, and the effects of geometry upon fabric behavior, and the importance of these behavior characteristics upon objective and subjective functional performance characteristics of textile structure.

This lecture will be published in December.

Gillett Lecture

The fourth H. W. Gillett Memorial Lecture, "Powder Metallurgy—Now (New Techniques, Improved Properties, Wider Use)" is by Fritz V. Lenel, Associate Professor, Department of Metallurgical Engineering, Rensselaer Polytechnic Institute.

The lecture is sponsored jointly by ASTM and Battelle Memorial Inst. and commemorates Horace W. Gillett, one of America's leading technologists and metallurgists and the first Director of Battelle.

The production of finished parts from metal powders where such parts can be made more economically from powders than by other fabricating methods is a relatively recent development. Although this was originally an American idea, very significant contributions have been made abroad. Such "structural parts" do not necessarily bear structural loads, but are made by powder metallurgy in competition with other fabricating methods.

Dr. Lenel points out that many machine "structural parts" are made from wrought steel, not because the mechanical properties of the steel are needed, but because steel is the cheapest raw material. The question of what strength, ductility, and toughness are actually needed should therefore be considered critically before a high-strength material is specified where a powder part might be used. If a material is specified of higher strength and therefore higher cost than is really required, the expected savings due to fabrication from powders may well be illusory.

Also described is the production of semifabricated products such as extrusions, forgings, sheet, rod, and wire from powder which has properties superior to those made by fusion metallurgy. These techniques have been particularly successful in the field of light metals.

Dr. Lenel describes the contributions of powder metallurgy in the development of materials possessing high strength at elevated temperatures, which are highly needed in such places as aircraft propulsion and atomic energy. The thermal shock sensitivity of cermets appears to have been overcome, and the present principal research effort is directed towards increasing their inherently low toughness.

This lecture is scheduled for publication late this year.

New ASTM Manual of Engine Test Methods for Rating Fuels

The Motor and Research Methods for determining knock characteristics of motor fuels, including a number of editorial changes in the six supplements which contain detailed information on the apparatus, reference materials, operation and maintenance of the engines and their installation and assembly, are being published in a separate Manual for Rating Motor Fuels by

Motor and Research Methods available this fall.

Following its publication the Aviation and Supercharge methods, together with their supplements, will be revised and brought up-to-date for publication in a companion manual. Likewise, the Cetane method for rating diesel fuels will be published in a separate manual together with supplementary information. It is expected that these two latter manuals will be available late in 1956 or early 1957.

Methods of Calibrating Upright Tanks (D 1220)

This publication contains the procedures for calibrating upright stationary tanks larger than a barrel or drum, wood tanks, underground tanks, and outside insulated tanks, exclusive of tank roofs and bottoms; methods for the measurement of or for accounting for the effects of floating roofs, variable volume roofs, and tank bottoms, on tank capacities, etc. It also gives tank capacity calculation methods, with formulas, tables, and a helpful bibliography.

Significance of Tests of Petroleum Products (STP 7 C)

This discussion was prepared under the auspices of ASTM Committee D-2 on Petroleum Products and Lubricants and is the third edition, the first having been published in 1928 and the second in 1934. It is designed for the reader who wishes to get a general idea of the various ASTM Methods of Test for Petroleum Products and their applications. Significance as related to the performance characteristics of the specific products is also discussed, so that the reader may have some idea of the limitations of the various methods. The language has been kept relatively free of technical terms for those who may not be acquainted with such terms.

The methods of test and their significance are discussed by sections, determined by general properties as follows: sampling petroleum products; measurement and calculation of volume; volatility; combustion; oxidation characteristics; flow characteristics and solidification; corrosion; other physical characteristics and tests; chemical analyses and tests; analysis for hydrocarbon types; and butadiene analysis.

The brief outlines of the methods of test in this book are not adequate for conducting tests. Full details and safety precautions required are given for each method in the official methods of test as published annually in ASTM Standards on Petroleum Products and Lubricants, or as otherwise indicated in the list of applicable standards under the jurisdiction of Committee D-2 at the end of each section of this book.

This publication is scheduled to appear in December.

Determination of the Shear Stability of Non-Newtonian Liquids (STP 182)

This material was prepared by N. D. Lawson of E. I. du Pont de Nemours & Co., Inc., for Section B on Viscosity Methods—Non-Newtonian Liquids of Research Division VII on Flow Properties of Committee D-2 on Petroleum Products and Lubricants. This section was assigned the responsibility of developing test methods for measuring the shear stability of non-Newtonian liquids and for measuring the viscosity of non-Newtonian liquids at high rates of shear. It was decided to undertake cooperative work to determine which, if any, of the methods in use at various laboratories were suitable for measuring the shear stability of mineral oils containing high molecular weight polymers. Various test methods are described and any of the various test procedures set forth in this report are capable of giving comparable results.

• **This publication is now available.** Copies can be obtained from ASTM Headquarters, 1916 Race St., Philadelphia, Pa. Price: 75 cents; to members, 65 cents.

Symposium on Insulating Oil (STP 172)

This symposium, the sixth in a series on transformer oils sponsored by Committee D-9 on Electrical Insulating Materials, reports European developments in the testing of transformer oils. It consists of three papers which report on research on the subject in France, Sweden, and England.

"Catalysts for Accelerated Aging Testing of Transformer Oil" by Halvard Liander and Gosta Fricson of Sweden discusses both solid and soluble metal catalysts. When solid copper is used as a catalyst, two events take place: a dissolution of copper in the oil; and oxidation of the oil, catalytically influenced by the dissolved copper. The copper is soon again precipitated as sludge and only small amounts remain in solution 0.05 to 0.2 ppm, as will be found in transformer oils in service. The advantage of employing soluble catalysts is discussed, and it is shown that inhibited as well as uninhibited oils may be readily evaluated with the aid of soluble catalysts. A mixture of copper and iron naphthenates is recommended for practical use.

In "The Evaluation of Inhibited Transformer Oils" by R. Irving and D. W. Bravey of England a series of inhibited transformer oils prepared from base oils having widely differing inhibitor susceptibilities is examined. Correlations are shown to exist between the results obtained by various oxidation tests in which the catalysts used were soluble copper, mixed soluble copper-soluble iron, and solid copper, respectively.

The French paper by T. Salomon on "The Performance Characteristics of Used Insulating Oils" is divided into three parts. In the first part, the mechanism of the oxidation of mineral oils at moderate temperatures and the fundamental differences existing between the oxidation under normal operation (oxidation *in vivo*) and that in the artificially accelerated laboratory test (oxidation *in vitro*) is discussed. How to interpret correctly the results obtained and how to establish the correlation between the results found in the laboratory and in the field is explained. In the second part the different parameters of the oxidation of oils in operation and their effect on the performance of the oils is discussed. The different techniques used to regard or to suppress the aging of the oils in operation is studied in the third part.

This publication is scheduled to appear in November.

Significance of Tests and Properties of Concrete and Concrete Aggregates (STP 169)

This new edition, the first published since 1943, has been greatly expanded to include not only the latest views on the significance of tests, but also the significance of properties of concrete and concrete aggregates. The papers contained in this publication constitute a review of the present status of testing of concrete and concrete aggregates and the significance of the properties for which tests may be made and have been prepared by the leading technical men of the country in the field of concrete and concrete aggregate testing. The book by Committee C-9 on Concrete and Concrete Aggregates, will be especially informative to students and those not directly connected with testing and research of concrete and concrete aggregates.

There are approximately 37 papers in this publication, grouped into four main parts, as follows:

I. General—Includes papers on both concrete and concrete aggregates dealing with Sampling, Evaluation of Results of Tests, and Needed Research.

II. Tests and Properties of Concrete—Papers cover Freshly-Mixed Concrete (Uniformity, Segregation, Density, Workability, Setting Time, Air Content); Hardened Concrete (Microscope Exami-

nation, Volume Change, Thermal Properties; Pore Structure, Air Content, Cement Content, etc.); Special Categories of Concrete (Ready-Mixed, Lightweight, etc.).

III. Tests and Properties of Concrete Aggregates—Papers cover Petrographic Examination, Particle Size, Shape, Weight, Porosity, Toughness, Thermal Properties, Chemical Reactions, Soundness and Deleterious Substances, etc.

IV. Tests and Properties of Other Materials—Papers cover Mixing and Curing Water, Curing Materials, Air Entraining Admixtures, Mineral Admixtures.

This publication is scheduled to be available in November.

Bibliographical Abstracts on Redeposition of Soil on Cotton Fabric (STP 173)

A task committee for the purpose of developing a method for measurement of deposition of soil onto fabric from aqueous detergent systems (laundering) was appointed in 1953. This task committee on redeposition methods of Subcommittee T-5 of Committee D-12 on Soaps and Other Detergents consisted of Messrs. M. G. Kramer, Wyandotte Chemical Corp.; Howard Paitchel, Colgate-Palmolive Co.; and W. A. Tidridge, Westvaco Chemical Div., Food Machinery and Chemical Corp. The first action of this group was to review the past literature to obtain information necessary for consolidation or revision of the best in current redeposition methods or for the development of a new method.

It was believed that publication of a bibliography covering this literature review would be of benefit to detergent workers. The bibliography is patterned after *Metal Cleaning Bibliographical Abstracts, STP 90.*

The references, which are numbered consecutively, are listed by year and then by author. The abstracts, in many cases, were prepared from the original article and are slanted generally towards giving an indication of the contents that are pertinent to testing methods and theories. Reference is made to *Chemical Abstracts* wherever possible.

Readers are being urged to advise the editors of any corrections or additions to be made in possible future editions. This volume is scheduled for the end of the year.

Bibliographical Abstracts on Evaluation of Brightening Agents for Detergent Usage (STP 177)

Brightening agents are essentially colorless dyes which, when applied on textiles, absorb ultraviolet irradiation and emit light of a bluish hue complimentary to the yellow tint already present on the off-white substrate. In this manner the brightening agents impart a greater apparent whiteness to the materials treated.

Although brighteners were originally applied to paper and still are, they were first incorporated in detergent compositions in about 1945. At present the growth of this application has expanded to the point where brightening agents are available for most types of fiber and detergent compositions. The literature on brightener evaluation methods has grown to a point where a bibliography of the published methods should prove useful to the persons engaged in the manufacture, analysis, development, and evaluations of brighteners in detergents. This bibliography has been prepared by L. E. Weeks of Monsanto Chemical Co. for Subcommittee T-5 on Physical Testing of Committee D-12 on Soaps and Other Detergents.

The style of this bibliography follows closely that of *Metal Cleaning Bibliographical Abstracts, STP 90.* The references, numbered consecutively, are listed by year and then by author, or by source in which the article appeared if anonymous. Most of the abstracts are based on the original articles, some are re-abstracts from *Chemical Abstracts.*

It is hoped to keep these abstracts current, and interested readers are therefore urged to advise Mr. Weeks of any corrections or additions to be made. This volume is scheduled for publication in November.

1954 Supplement to the Bibliography and Abstracts on Electrical Contacts (STP 65-I)

The size of this year's edition of the Bibliography and Abstracts on Electrical Contacts indicates that work in this field is continuing at a high level of activity. Of particular interest is the increase in the number of publications concerning the relation between circuit and circuit parameters and contacts and switching operations. This is the second supplement published to the 1952 edition, and this 42-page book is now available.

1954 References on Fatigue (STP 9-F)

Following the plan used in previous annual lists (1950–1953) of fatigue references the latest list of references to articles published in 1954 on the subject of fatigue is now available. Brief abstracts of the articles have been included when these were readily available. This list is not exhaustive but is sufficiently extensive to be of interest to those concerned with this field. References are generally so arranged that sheets can be cut apart for filing according to any desired plan. Committee E-9 on Fatigue sponsored this project.

Report on Standard Samples for Spectrochemical Analysis (STP 58 C)

Quantitative spectrochemical analysis is based on comparison of unknown samples with standard samples of similar composition. Standard samples are frequently prepared by the analyst for the particular problem in hand, but for the analysis of many common materials, particularly metals and alloys, standard samples have been prepared in quantities adequate for general distribution. The rapid growth of spectrochemical analysis and a corresponding increase in available standard samples call for a periodic compilation of types and sources of standards for the information of analysts.

This fourth edition will be available at the end of this year.

The Mechanical Properties of Wrought Phosphor Bronze Alloys

This publication showing the effect of cold-working on the mechanical properties of a series of eight phosphor bronze alloys in the form of cold-rolled strip, was prepared by Messrs. G. R. Gohn and J. P. Guerard of the Bell Telephone Laboratories and H. S. Freynik of the Riverside Metal Co. Division of H. K. Porter Co., Inc.

The tin content of the alloys varied from 0.5 to 10 per cent. Each material was furnished with two ready-to-finish grain sizes. Electrolytic tough pitch copper strip similarly treated is included to provide a base for evaluating the effectiveness of the tin additions. The mechanical properties are reported for six different tempers of each of the 18 materials. The tempers studied include annealed, half-hard, hard, extra-hard, spring, and extra-spring. Data are also included on the 3, the 4, and the 5 higher phosphorus content. The effect of a larger ready-to-finish grain size on the mechanical properties of the high phosphorus, 4 per cent tin alloy is discussed.

It was felt it would be of value to publish this material which shows a systematic study of the phosphor bronzes to determine the effect of variations in tin and phosphorus on the mechanical properties, with special emphasis on alloys in the range of 3.5 to 5.8 per cent tin; to show the effect of variations in cold working on the mechanical properties of the various alloys; to establish the effect of variations in grain size on the mechanical properties of these alloys; and to obtain the necessary data to permit the establishment of realistic specification limits for tin in the nonleaded compositions.

This publication will be available early next year.

Latest Actions on Standards

MEETING at ASTM Headquarters on September 15, the Administrative Committee on Standards took affirmative action on a number of recommendations from twelve of the Society's technical committees. The main features of these approved new tentatives and changes in existing specifications are summarized briefly below as they were presented by the various committees.

Steel

In response to a request by a group of producers and consumers interested in promulgating an industry-wide standard for transmission tower bolts, Committee A-1 developed Tentative Specifications for Galvanized Steel Transmission Bolts (A 394) covering chemical and mechanical requirements of nuts and bolts ranging in size from $\frac{1}{2}$ to 1 in. in diameter, preferably to be furnished in $\frac{1}{8}$-in. diameter steps and in $\frac{1}{4}$-in. length steps.

Approval was also given the committee's recommendations to withdraw Emergency Alternate Provisions for Steel Tires (EA–A 26) and to revise the Emergency Alternate Provision for Heat-Treated Steel Tires (EA–A 329). Both actions relate to the deletion of the emergency alternate provision raising the maximum phosphorus and sulfur limits, since the emergency which called for this provision no longer exists. However, the committee wished to continue in EA A 329 the alternate provision which brings manganese content in line with that of Specification A 26.

Prior to their September meeting, the Standards Committee approved on August 31, a revision in Table I of Forged or Rolled Alloy-Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service (A 182). To make it consistent with other ASTM specifications for other products such as pipe, tubing, bolting, welding fittings, etc., the identification symbol F5a (0.25 max per cent carbon) is added. Previously in these specifications this grade was assigned the identification symbol F5 which is now assigned to the 0.15 max per cent carbon grade.

Cast Iron

Approval was given to two new specifications relating to nodular iron, also known as spheroidal or ductile iron: Tentative Specifications for High-Strength Nodular Iron Castings (A 396) was written in response to a demand by producers and consumers for a specification covering nodular iron when it is heat treated to produce high strength. A sizable tonnage of this iron is used especially for gears and other wearing parts. Committee A-3 felt that a separate specification should be written rather than including it in Specifications for Nodular Iron Castings (A 339).

Tentative Specification for Cast Nodular Iron for Pressure-Containing Parts for Temperature Ranging from −20 F to Elevated Temperatures (A 395) was developed by a special task group of the ASME Boiler and Pressure Vessel Committee, and was submitted for approval to ASTM Committee A-3 and the interested subcommittee. The ASME Boiler and Pressure Vessel Committee uses ASTM specifications exclusively in Section II (Material) of the Boiler and Pressure Vessel Code.

Cement

Committee C-1 recommended revision and reversion to tentative of Specifications for Masonry Cement (C 91) to provide for use of the same testing procedure for strength and air entrainment currently required in Federal Specifications; to require mechanical

Actions Taken by Standards Committee, September 15, 1955

New Tentatives

Specifications for:

- Galvanized Steel Transmission Bolts (A 394–55 T)
- High-Strength Nodular Iron Castings (A 396–55 T)
- Cast Nodular Iron for Pressure-Containing Parts for Use at Elevated Temperatures (A 395–55 T)

Methods of:

- Testing Spun and Filament Yarns Made Wholly or in Part of Man Made Organic Base Fibers (D 1380–55 T)
- Estimating the Grain Size of Metals (E 112–55 T)
- Acid Number (Empirical) of Natural Waxes (D 1386–55 T) (Approved July 25, 1955)
- Saponification Number (Empirical) of Natural Waxes (D 1387–55 T) (Approved July 25, 1955)

Definitions of:

- Terms Relating to Magnesium Oxychloride and Magnesium Oxysulfate Cements (C 376–55 T)

Recommended Practice for:

- Ultrasonic Testing by the Reflection Method Using Pulsed Longitudinal Waves Induced by Direct Current (E 114–55 T)
- Resonance Method of Ultrasonic Testing (E 113–55 T)

Revisions of Standards and Reversion to Tentative

Specifications for:

- Masonry Cement (C 91–55 T)

Method of:

- Testing Pasted Mica Used in Electrical Insulation (D 352–55 T)
- Testing Tall Oil (D 803–55 T)

Definitions of:

- Terms Relating to Metallography (E 7–55 T)

Tentative Revisions of Standards

- Standard Strength Clay Sewer Pipe (C 13–54)
- Standard Strength Perforated Clay Pipe (C 211–50)
- Standard Strength Ceramic Glazed Clay Sewer Pipe (C 261–54)
- Building Brick (Solid Masonry Units Made from Clay or Shale) (C 62–50)
- Facing Brick (Solid Masonry Units from Clay or Shale) (C 216–50)
- ASTM Thermometers (E 1–55)

Methods of:

- Sampling and Testing Brick (C 67–50)

Revisions of Tentatives

Specifications for:

- Extra Strength Clay Pipe (C 200–55 T)
- Extra Strength Ceramic Glazed Clay Pipe (C 278–55 T)
- Ceramic Glazed Structural Clay Facing Tile, Facing Brick, and Soil Masonry Units (C 126–55 T)
- Gasoline (D 439–55 T)
- ASTM Hydrometers (E 100–55 T)
- Forged or Rolled Alloy-Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service (A 182–55 T) (Approved Aug. 31, 1955)

Method of:

- Test for Needle Penetration of Petroleum Waxes (D 1321–55 T)

Revision of Emergency Alternate Provisions

- Heat Treated Steel Tires (EA–A 329)

Withdrawal of Emergency Alternate Provisions

- Steel Tires (EA–A 26)

mixing of three parts blended sand to one part masonry cement by volume, in which the cubic-foot weight of masonry cement is considered to be the weight printed on the bag.

Magnesium Oxychloride and Magnesium Oxysulfate Cements

The development of specifications and test methods by Committee C-2 has made it necessary to prepare standard definitions of the terms used in these specifications and by the industry. Tentative Definitions of Terms Relating to Magnesium Oxychloride and Magnesium Oxysulfate Cements (C 376) cover: aggregate, compressive strength, consistency, filler, flexural strength, gauging ratio, gauging solution, linear change, linear contraction, magnesia, magnesium oxychloride, magnesium oxychloride cement, magnesium oxychloride composition, nonplastic contraction, oxychloride magnesia, setting time, standard conditions, and Westvaco needle.

Clay Pipe

In Tentative Specifications for Extra-Strength Clay Pipe (C 200), Tentative Specifications for Extra-Strength Ceramic Glazed Clay Pipe (C 278), and Standard Specifications for Standard Strength Perforated Clay Pipe (C 211), identical revisions are made to change the ratio of three-edge bearing to sand bearing, to provide minimum lengths for pipe only, thus allowing the manufacture of longer lengths; to eliminate scoring of pipe where factory-made joints were used; and to eliminate the 10 per cent acceptance clause for pipe which failed to meet ASTM specifications.

Tentative revision of Standard Specifications for Standard Strength Clay Sewer Pipe (C 13) increases crushing strengths of certain sizes of pipe to bring crushing strengths of all sizes into more proper balance. The 10 per cent clause providing for acceptance, and the scoring of factory made joints were also eliminated and minimum lengths specified.

Standard Specifications for Standard Strength Ceramic Glazed Clay Sewer Pipe (C 261) were revised with the elimination of the 10 per cent acceptance clause and scoring of factory-made joints, and the addition of minimum lengths of pipe.

Manufactured Masonry Units

Committee C-15 proposed revision of two tentative specifications and tentative revision of two standard specifications:

In Tentative Specifications for Ceramic Glazed Structural Clay Facing Tile, Facing Brick, and Solid Masonry Units (C 126) weathering requirements are deleted since units conforming to these absorption requirements cannot always be guaranteed to resist weathering. Based on exposure tests and extensive job experience, it is the consensus that such requirements are more properly included in construction specifications based on the specific recommendations of the manufacturer of the product involved.

Methods of Sampling and Testing Brick (C 67) are tentatively revised by the change in Paragraph 15(a) to read as follows:

The test specimens shall be dried in a ventilated oven at 110 to 115 C (230 to 239 F) for not less than 24 hr and until two successive weighings at intervals of 2 hr show an increment of loss not greater than 0.2 per cent of the last previously determined weight of the specimen.

Standard Specifications for Building Brick (Solid Masonry Units Made from Clay or Shale) (C 62) and Specification for Facing Brick (Solid Masonry Units Made of Clay or Shale) (C 216) are revised for identical reasons—to provide for thorough explanation in the explanatory notes of the significance of proper control of the suction of brick at the time of laying, a factor considered of great importance in obtaining good mortar adhesion, complete bond, and water-impermeable joints of high strength.

Petroleum Products and Lubricants

Committee D-2 recommended revision of Tentative Specifications for Gasoline (D 439) to reflect the increase in octane number levels for regular and premium gasoline as given in the National Motor Gasoline Winter Survey.

Revisions in Tentative Method of Test for Needle Penetration of Petroleum Waxes (D 1321) are largely editorial in nature and in clarification of a few technical details.

Electrical Insulating Materials

A proposed revision of Standard Methods of Testing Pasted Mica Used in Electrical Insulation (D 352) has been published as information in the 1955 D-9 compilation. Nineteen revised sections replace Sections 1 through 14 of the former methods. The purpose of the revisions is to include new commercially available materials that logically fall within the scope of these methods; to recommend the use of generally employed convenient apparatus; and to include additional test methods.

Textile Materials

An important advance in the technique of yarn testing that represents several years' study by Committee D-13 is Tentative Methods of Testing Spun and Filament Yarns Made Wholly or in Part of Man-Made Organic Base Fibers (D 1380). The new methods are a revision and consolidation of the following three test methods which are accordingly withdrawn:

Methods of Testing and Tolerances for Spun Rayon and Acetate Yarns and Threads (D 507)
Tentative Methods of Testing Continuous Filament Man-Made Organic Base Yarns (D 258)
Methods of Testing and Tolerances for Yarns Spun from Mixed Fibers (D 508).

The new methods do not establish the specifications and tolerances applicable to a given yarn as such, but rather, they establish the procedures by which a given yarn may be tested for subsequent evaluation in terms of the established specifications or tolerances for the yarn in question.

Naval Stores

The principle revisions made by Commitee D-17 in Standard Methods of Testing Tall Oil (D 803) (now reverted to tentative) are: in the section under Color the two methods are now designated "A" and "B" rather than "Preferred" and "Alternate"; limiting the Referee Method to tall oils containing more than 15 per cent rosin acids; changing esterification time from 2 min to 30 min in both the Referee Method and in Alternate Method A; substitution of the method recently standardized for unsaponifiable matter in rosin for the present method for comparable results.

Wax Polishes and Related Materials

Two widely used analytical or control methods are embodied in the new tentative methods recommended by Committee D-21 and approved by the Standards Committee on July 25, 1955:

Tentative Method of Test for the Saponification Number (Empirical) of Natural Waxes (D 1386) defines saponification number as the number of milligrams of potassium hydroxide required to hydrolyse 1 g of wax sample, thereby providing a measure of the amount of saponifiable matter present.

Tentative Method of Test for Acid Number (Empirical) of Natural Waxes (D 1387) employs the direct titration method. Using an ethanol, toluene mixture this method is applicable to all natural waxes including carnauba. It is also applicable to oxidized microcrystalline waxes when a single solvent, normal propanol, is used to improve solution of these higher melting point waxes.

General Methods of Testing

Revisions in Standard Specifications for ASTM Thermometers (E 1) include the addition of six tentative thermometer specifications for ASTM fuel rating and also revision of the antifreeze thermometers 75 F and 76 F. The six new thermometers were requested by Committee D-2 for use in the ASTM Knock Test Methods (D 357 and D 908). The revision of the freezing point thermometer involves the inclusion in Table II of emergent stem temperature corrections as submitted by the National Bureau of Standards.

Committee E-1 also revised the Tentative Specifications for ASTM Hydrometers (E 100) to add 27 specific gravity hydrometers for general testing use in response to an indicated need for hydrometers in these specific gravity ranges. The new hydrometers supplement the API ones and the thermohydrometers previously covered by these specifications.

Metallography

Committee E-4, aware of the inadequacy of the Standard Definitions of Terms Relating to Metallography (E 7) caused by the tremendous expansion in the field of metallography since 1927 has revised and reverted to tentative these definitions, making them a compendium of the terms now in use in a thoroughgoing amplification of the old standard.

Committee E-4 also has prepared Tentative Methods for Estimating the Grain Size of Metals (E 112) as a basic method for all metals and alloys, realizing that a grain is the same unit of metal, whether it is iron, aluminum, magnesium, copper, nickel, or any other metal or alloy. Employing comparison charts, three basic methods are covered, including comparison, planimetric (or Jeffries) and intercept (or Hehn). The several grain size methods presently in use evolved from different branches of metallurgy. It is intended that eventually Methods E 112 will supplant Methods E 19 for Austenitic Grain Size, E 89 for Ferrite Grain Size, E 79 for Copper and Copper Base Alloys, and E 91 for Other Non-Ferrous Metals and Alloys.

Nondestructive Testing

Two new practices, recommended by Committee E-7, are intended as a guide for certain types of ultrasonic tests for soundness of materials and have been in development for more than three years. They are Tentative Recommended Practice for the Resonance Method of Ultrasonic Testing (E 113) and Ultrasonic Testing by the Reflection Method Using Pulsed Longitudinal Waves Induced by Direct Contact (E 114).

Chemical Society Cooperates with ASTM on Standards as Matter of Policy

In May this year, the American Chemical Society went on record in its official published report[1] as favoring cooperation with established standardization agencies. Because of the widespread interest in ASTM in matters relating to chemicals, the report of the ACS Committee on Standardization Policy Cecil L. Brown, chairman, is given below:

Standardization Policy

The American Chemical Society should continue to encourage all needed standardization in the fields of chemistry and chemical industry. The Society should recognize, however, that except for a limited number of distinctly chemical activities such as standardization of nomenclature and atomic weights, it is better to work through agencies specifically organized for standardization work, such as the American Standards Association and the American Society for Testing Materials. The Society should neither initiate nor continue alone standardization activities which the standardization agencies can and will handle in satisfactory fashion. The Society should be represented on pertinent committees of the standardization organizations to insure and safeguard the interests of chemists and chemical industry.

Explanation

The American Chemical Society through its committees or division committees conducts standardization work or develops proposals which are used by outside agencies for establishing standards. These activities are discussed below together with the recommendations made by the Subcommittee on Standardization Policy in each case. The specific recommendations led to the general policy statement which precedes. The Society has committees on atomic weights and nomenclature and these may be considered as establishing standards in these fields. The subcommittee recommends continuance of these activities in their present form since the Society has primary interest in these fields and since no other agency can satisfactorily substitute for the Society.

The Society has Committees on Standard Apparatus and on Analytical Reagents. The first-named does not set standards but has made recommendations on apparatus to manufacturers. The subcommittee makes no suggestion about this committee except that for a change in name to delete inferences of standardization.

The Committee on Analytical Reagents has been establishing standards. The subcommittee recognizes its several years of success and is agreeable to its continuance with the proviso that its standardization efforts be shifted to a standardization agency at such time as this appears desirable.

The Society appoints representatives to standardization agencies such as the American Standards Association. The subcommittee recommends continuation of this practice.

A committee of the Division of Cellulose Chemistry develops analytical procedures which are submitted to an ASTM Committee D-23 on Cellulose and Cellulose Derivatives for establishments of standards. The organization of Committee D-23 was initiated by members of the Division of Cellulose Chemistry acting under the procedures of ASTM. The subcommittee recommends this type of procedure for all cases in which an existing outside agency can efficiently care for the standardization step.

The Committee on Microchemical Apparatus of the Division of Analytical Chemistry has developed recommended specifications for equipment. Sanction for using terms inferring "ACS Standards" has been requested by some apparatus manufacturers. The subcommittee recommends that the work on recommended specifications be continued as a division activity and that approval of these recommended specifications by either the Council or the Committee on Standard Apparatus be discontinued. Sanction for the label "ACS Standards" should not be granted. The subcommittee recommends that the procedure for converting the specifications to standards be conducted by an agency other than ACS and suggest the ASTM for this purpose.

In general the subcommittee proposes the use by ACS of established standardization agencies when the interests in ACS can be properly furthered and protected by such use.

[1] ACS Official Reports, *Chemical and Engineering News*, Vol. 33, No. 20 (May 16, 1955).

ALL ITEMS ON STANDARDS BALLOT APPROVED

The canvass of the results of the 1955 letter ballot shows that the membership of the Society has approved all the items listed on the ballot. These included 141 revisions of existing standards, and 105 adoptions of tentatives as standards; and By-Laws changes relating to the establishment of a new "Associate Membership." (See page 14.)

Details concerning these actions were given in the Summary of Proceedings of the Fifty-eighth Annual Meeting, which was mailed to all members in August, together with the letter ballots.

ASTM Bulletin

OCTOBER 1955

NO. 209

NINETEEN-SIXTEEN
RACE STREET
PHILADELPHIA 3, PENNA.

Short Case History of a New Activity

A REVIEW of events leading to the decision by the Directors to undertake standardization and research work on hydraulic fluids will impress one with the careful study devoted to new projects in the Society and at the same time provide some idea of the considerable time and effort involved in eliciting various viewpoints on problems to be covered.

The use of so-called hydraulic fluids, both synthetic and petroleum base, has grown tremendously in recent years in a variety of applications. Properties such as lubricity, flammability, and behavior at extreme temperatures are among those of major importance.

The various responsible groups in the Society are constantly alert to problems in which ASTM activity would be of service to industry and Government. Suggestions from the President, Directors, officers of technical committees, and the Staff, are reviewed through appropriate channels.

In the case of hydraulic fluids one of our then active Directors, Howard Nason, wrote to the President, suggesting that consideration be given to needs in this field. This proposal was reviewed briefly by the Board's Committee on Technical Committee Activities, and members of the Staff discussed the subject with other Society members, both consumers and producers, and other organizations and individuals who might be concerned, such as Departments of the Government and the Society of Automotive Engineers. Finally, a full-scale conference was authorized by the Board and held at ASTM Headquarters, attended by some fifty individuals representing a wide range of interests. G. H. Harnden, in his capacity as a member of the Administrative Committee on Standards, presided. The transcript of the very interesting discussion, covering 130 pages, indicates a very careful and complete review of the many facets in the problem of preparing standards on this type of material.

It was agreed, virtually unanimously, that work in this area would be constructive and that it should be started promptly. Accordingly a Steering Committee was set up to outline the scope of activities and to suggest officers. In this instance a new main technical committee was not considered necessary but it was recommended that a new technical committee be set up under Committee D-2 on Petroleum Products and Lubricants. Much of the work of the latter committee would be of direct interest in the new work and the personnel would be made representative of the synthetic interests.

The recommendations of the conference were approved by the Administrative Committee on Standards and in turn by the Board of Directors so that an organization meeting of the committee is being held at the time of the meeting of Committee D-2 in Washington in October.

A major effort is made in connection with study and decision on new projects that all interests concerned shall have an opportunity to express their views fully and frankly. Obviously, opinion cannot always be unanimous, but the various viewpoints are evaluated by the Directors and decision is reached on the basis of whether the work will be of service to industry, and whether the expenditure of time and energy of everyone concerned will be justified.

Carbon Black

Another new area of work, approved by the Directors, is in the field of carbon black. A group of technical leaders representing producers who had been developing analytical procedures, suggested that ASTM study these and undertake standardization. Further announcement will be forthcoming on this new activity which will necessitate the organization of a new technical committee composed of representatives from the various industries concerned and from ASTM technical committees such as D-11 on Rubber and Rubber-Like Materials; D-1 on Paint, Varnish, Lacquer, and Related Products; C-1 on Cement; D-20 on Plastics; Printing Ink, and others.

ANNOUNCEMENT TO MEMBERS

New Class of ASSOCIATE Membership

- Established 1955 by action of the Board of Directors and Letter Ballot of the Membership
- To become effective January 1, 1956
- Extending the former "Junior" class from age limit of 27 to 30 years
- With annual dues of $10, and entrance fee of $5
- Publication privileges same as for Full Members, except that there is a *choice* of *one Part of the Book of Standards or Proceedings* (nominal annual charges of $3 each applying for additional Parts of the Book of Standards; and a flat additional annual charge of $3 if copy of *Proceedings* also is desired).

Revised folder about the Society and membership application blank are now available from Headquarters. All current members are urged to help build up this new class through "word of mouth" to associates of business acquaintances, or by submission of names of prospective members to the Membership Committee, care of Headquarters Office.

It is hoped that establishment of the ASSOCIATE class will eventually effectuate a greater percentage of younger ASTM members—in the engineering educational field, in the testing and laboratory apparatus fields, and in industry in general.

Reed and Crampton to Present 1956 Memorial Lectures

Two recognized authorities in their fields will present the Marburg and Gillett Lectures at the 1956 Annual Meeting of the Society in Atlantic City the week of June 17.

Charles E. Reed, General Manager, Silicone Products Department, General Electric Co., Waterford, N. Y., will deliver the Marburg Lecture on the subject "Silicones."

D. K. Crampton, Director of Research, Chase Brass and Copper Co., Waterbury, Conn., the Gillett Lecturer, will speak on "Copper—Newer Facts About an Older Metal."

The purpose of the Edgar Marburg Lecture, which commemorates the Society's first secretary, is to have described at annual meetings by leaders in their respective fields, outstanding developments in the knowledge of materials.

The H. W. Gillett Memorial Lecture, established jointly by ASTM and Battelle Memorial Inst. in honor of the great American metallurgist and first director of Battelle, covers subjects pertaining to the testing, evaluation, and application of metals.

Schedule of ASTM Meetings

This gives the latest information available at ASTM Headquarters. Direct mail notices of all district and committee meetings customarily distributed by the officers of the respective groups should be the final source of information on dates and location of meetings. This schedule does not attempt to list all meetings of smaller sections and subgroups.

Date	Group	Place
Nov. 3	Southwest District Meeting—Joint with ASM	Dallas, Texas
Nov. 3–4	Committee F-1 on Materials for Electron Tubes and Semiconductor Devices	Washington, D. C. (Sheraton Park)
Nov. 7–9	Committee C-13 on Concrete Pipe	Chicago, Ill. (Union League Club)
Nov. 10–11	Committee B-4 on Metallic Materials for Electrical Heating, Electrical Resistance, and Electrical Contacts	Philadelphia, Pa. (Society Headquarters)
Nov. 14–16	Committee D-20 on Plastics	Cincinnati, O. (Netherlands Plaza)
Nov. 16–18	Committee D-9 on Electrical Insulating Materials	Cincinnati, O. (Netherlands Plaza)
Nov. 17	Ohio Valley District Meeting—Joint with AIEE	Cincinnati, O.
Nov. 18	Philadelphia District Meeting—Joint with ASQC	Philadelphia, Pa. (Franklin Institute)
1956		
Jan. 30–Feb. 1	Committee A-1 on Steel	Pittsburgh, Pa. (Wm. Penn Hotel)
Feb. 5–10	Committee D-2 on Petroleum Products and Lubricants	Dallas, Texas (Statler-Hilton)

Changes in 1955 Year Book—Geographic Section Omitted

As a result of discussions in the Staff and at meetings of the Directors, a number of changes are being made in the 1955 Year Book. For the most part, these are to effect economies through reducing the number of pages in the book. It is hoped the omissions will not materially reduce the utility of the book. Members who may feel strongly that certain sections that have been omitted should be restored need have no hesitancy in advising the Executive Secretary to this effect.

One of the most expensive sections to maintain has been the Geographic Distribution of Members covering some 60 pages in small type. Each year, because of the many changes, this has virtually been reset. As a trial, it is being omitted from this year's book, but if its omission proves to be too much of a handicap, consideration will be given to its restoration. Each new member of the Society is of course listed in the ASTM Bulletin and these listings are arranged according to the geographic district in which they are located. Maps of the United States and the larger individual maps of the fourteen districts will continue in the Year Book immediately following the personnel of the various District councils in the front part of the book.

Other portions of the Year Book being withheld this year are the list of deceased members for the past five years, the separate list of sustaining members (these are identified in the alphabetical list with a special mark), the Regulations Governing the Board of Directors, and the Regulations Governing Technical Committees. Reprints of this material, however, are available on request. The larger portion of the Year Book will continue to consist of the extensive personnel of the large number of ASTM Technical Committees.

With the deletion of the material indicated, the Year Book can be reduced from 680 to about 600 pages.

1956 Award of Merit Committee

With the acceptance of B. A. Anderton and M. A. Swayze, the personnel of the 1956 Award of Merit Committee is completed. These two men will serve with hold-over members, G. L. Werley, chairman, and W. C. Clements. N. L. Mochel will represent the Board of Directors on the committee.

ASME 75th Anniversary Meeting

The American Society of Mechanical Engineers' Diamond Jubilee Annual Meeting which will be held in Chicago at the Congress, Conrad Hilton, and Sheraton-Blackstone Hotels, November 13 to 18, will feature special events commemorating ASME's 75th anniversary.

ASME conferees will hear and discuss more than 300 technical papers at 110 sessions covering a variety of subjects: aviation, applied mechanics, management, materials handling, oil and gas power, fuels, safety, hydraulics, metals engineering, heat transfer, process industries, production engineering, machine design, petroleum, nuclear engineering, railroad, power, textile, gas turbine power, wood industries, rubber and plastics, and instruments and regulators.

The American Rocket Society, an affiliate of ASME, and celebrating its 25th anniversary this year, is holding its sessions within the ASME meeting.

The Chicago Section of ASME will be hosts to their fellow-Society members and have arranged an interesting and diversified program of events for them. A dinner and pageant highlighting ASME milestones from 1880 to the present is listed for Tuesday evening. A new timely section on Atomic Power will also be featured.

Technical Committee Notes

Methods of Atmospheric Sampling and Analysis

Committee Meets During ACS Sessions in Minneapolis

OCCUPYING a pivotal spot in the nation's search for solutions to the growing problems of air pollution is ASTM's Committee D-22 on Methods of Atmospheric Sampling and Analysis which met on September 12 at the University of Minnesota, Minneapolis. The meeting was held in conjunction with the 128th Meeting of the American Chemical Society which from September 11 to 16 fitted nicely into the ample facilities of the University of Minnesota. A feature of the ACS meeting was the symposium on the Chemistry of Pollutants in the Atmosphere in which a number of members of Committee D-22 participated.

The D-22 meeting consisted essentially of reports of progress by chairmen of subcommittees and a discussion of some plans for the future. Reports from subcommittee chairmen indicated progress toward a number of new standards. About ready for committee ballot is a tentative method of test for odor concentration in air and gases and a method for determining fluorides in the atmosphere.

Instruments for measuring and recording the concentration of various pollutants are increasingly being used for continuous monitoring and as a means of warning against incipiently dangerous smog conditions, particularly in the Los Angeles area. A method for continuous automatic determination of dust load in the atmosphere is currently occupying the attention of the instrumentation subcommittee. Other pollutants for which instrumental methods are being investigated include fluorides and oxides of nitrogen. Methods for determining fluorides are being coordinated with similar methods under the jurisdiction of Committee D-19 on Industrial Water.

Because of the crucial importance of sampling to the accuracy and dependability of analytical data, a major portion of the effort of the committee is in this area. Efforts are being directed to the development of standard methods of sampling of particulate matter and of gases and vapors. Other projects not as far advanced are concerned with stack sampling and with sampling of soils, crops, and certain other materials which change in composition on exposure to various atmospheric contaminants.

Cellulose and Cellulose Derivates

New Fields of Testing Discussed at Meeting

IN KEEPING with its cooperative arrangement with the Division of Cellulose Chemistry of the American Chemical Society, the committee held a two-day meeting on September 11–12 in conjunction with the 128th meeting of the ACS in Minneapolis. Keynoting the round-table discussions this year—an annual feature—were the subjects of statistics and new fields of analysis.

It was revealed that the manual on statistics for general use within the committee and under preparation for some time has been completed and is being reviewed by committee members prior to final assembly. It is the intention that statistics shall be applied in all pertinent standards, both the new ones and those already issued.

The Subcommittee on Cellulose opened a round-table discussion with the subject—"What do we need in the way of new and improved methods for cellulose?" This spurred a lively discussion covering entirely new fields of analysis that brought to light many new approaches to cellulose testing. This

To ASTM Members: Your help is needed in maintaining that constant increase in ASTM Membership

To the ASTM Committee on Membership
1916 Race St., Philadelphia, 3, Pa.

Gentlemen:

Please send information on membership to the company or individual indicated below:

_____

_____

This company or individual is interested in the following subjects: indicate field of activity, that is, petroleum, steels, non-ferrous, etc.

_____

Signed _____

Date _____ **Address** _____

information will serve as the basis for future lines of investigation of the committee as a whole. Some of the new methods considered were in the fields of the near-infrared, chromatography, isotope tracers, chelation, and functional group methods.

Four methods of testing sodium carboxymethyl cellulose were reported as being in the final stage of preparation by the subcommittee. These methods are the degree of etherification, viscosity, sodium chloride content, and sodium glycolate content of sodium carboxymethyl cellulose. Cellulose methods in various stages of completion are disperse viscosity, pentosan content, color, ash constituents, hot and cold alkali solubility, and a molecular chain length procedure.

Analysis of Residual Fuel Oils—An Abstract

THE EFFECT of sodium and vanadium on the ash formed in boilers fired with residual fuel oil has caused various users and suppliers of this fuel to become interested in methods for determining these metals in the oil. Research Division III on Elemental Analysis of ASTM Committee D-2 on Petroleum Products and Lubricants was asked to investigate the feasibility of methods for this analysis. Spectrographic methods for sodium and vanadium, flame photometric methods for sodium, and colorimetric methods for vanadium were investigated. The flame photometric method for sodium developed by the Division has been standardized and is published as ASTM Method D 1318-54 T[1]. The colorimetric method for vanadium developed by the Division has been standardized and is published as information in the 1955 report of Committee D-2.

Limited cooperative testing of spectrographic methods has been completed and a report summarizing the results of these tests has been prepared. The methods included procedures based on ashing the oil and the determination of sodium and vanadium in the ash, and sparking the oil directly. The cooperative study revealed that ash determinations varied between laboratories and that analyses based on these procedures showed deviations for sodium and vanadium corresponding to the deviations in the ash determination. The results on direct sparking of the oils, however, were not superior.

Copies of the report summarizing the spectrographic portion of the program are available from W. J. Troeller, Jr., Secretary of Research Division III (ASTM D-2), Esso Research and Engineering Co., Products Research Division, P. O. Box 51, Linden, N. J.

[1] "Tentative Methods of Test for Sodium in Residual Fuel Oil by Flame Photometer," D1318 - 54T, 1954 Supplement to 1952 Book of ASTM Standards, p. 146.

Fatigue and Creep-Rupture of Reinforced Plastics Subject of SPI Symposium

THE Reinforced Plastics Division of the Society of the Plastics Industry is organizing for its February, 1956, meeting in Atlantic City, a technical symposium on the longtime strength properties of these materials. Authors who wish to offer papers should submit, as soon as possible, abstracts of 50 to 100 words to C. R. Stock, American Cyanamid Co., Stamford, Conn.

The lack of knowledge of longtime loading effects on plastics containing strong fibrous reinforcements such as glass, has become more and more evident with the increasing application of these materials to aircraft parts, building construction, pipes and tanks, and other structural uses. The symposium contemplates bringing together speakers with the latest available information and also pointing up for all concerned, areas needing further investigation. Another result of the symposium should be to help unify efforts on the part of the industry to gain knowledge presently lacking.

Fatigue of steels and the light metals, as well as some copper-base alloys, have been under study for a decade or more. Even the newer titanium alloys have received much attention for a number of years, both for fatigue and creep, especially at elevated temperatures. Long-term loading data are sorely needed for reinforced plastics, for those applications where plastics have potential plus values (for example, weight, corrosion resistance). The SPI symposium is expected to be a significant step in this direction.

Society of Rheology 1955 Annual Meeting

THE Society of Rheology will hold its Annual Meeting in New York City at the Henry Hudson Hotel on November 2 to 4, 1955.

This year's meeting will feature an unusually wide field of subject matter. The first session, on Wednesday afternoon, will be concerned primarily with plasticity studies of metals. On Thursday morning, flow phenomena encountered in geological studies will be covered. The session on Friday morning will be devoted to papers on the rheology of polymeric materials. The other two sessions on Wednesday and Friday afternoons, will be devoted to papers on a number of different subjects, including hypoelasticity, fracture of viscoelastic liquids, and determination of dispersion structure by viscometry.

To ASTM Nonmembers: The Society welcomes inquiries on the "Advantages of Membership"

To the ASTM Committee on Membership
1916 Race St., Philadelphia 3, Pa.

Gentlemen:

Please send me information on Membership in ASTM and include a membership application blank.

Signed _____

Address _____

Date _____

Random Samples...

FROM THE CURRENT MATERIALS NEWS

From the broad stream of current materials information flowing from "in-box" to "out-box" in a busy editorial office, random samples (mostly random) have been plucked. Thinking them worth re-showing to ASTM'ers who may have missed the original articles, we have included them here. Of course, we had to trim the samples to fit. There will be those who are not satisfied with samples, especially ones which are not really random. But these ASTM'ers can contact the institution, magazine, governmental agency, etc., who placed the original information in the stream, or address Random Samples, ASTM, 1916 Race St., Philadelphia 3, Pa.

Details of Nation's First Full-Scale Nuclear Electric Plant Revealed

THE UNITED States' first full-scale nuclear power plant for the generation of electricity will be fueled by 12 tons of natural uranium in the form of a "blanket" that surrounds some 115 lb of highly enriched uranium "seed." These details about the reactor core were revealed on August 15 at the International Conference on Peaceful Uses of Atomic Energy, Geneva, Switzerland.

Other previously classified details of the pressurized water reactor power plant, which will be located at Shippingport, Pa., near Pittsburgh, were disclosed in a technical paper written by representatives of the Westinghouse Electric Corp., Duquesne Light Co., and the U. S. Atomic Energy Commission.

The plant will contain a 100,000-kw turbine generator which will begin to deliver at least 60,000 kw of electricity to homes and industry in the Pittsburgh area in 1957.

Most of the power from the reactor will come from the fissioning, or splitting, of uranium 235 atoms. Some power will even come from the splitting by high-speed neutrons of normally nonfissionable uranium 238. A "substantial fraction" of the power will come from the splitting of atoms of plutonium—a fissionable product of reacting uranium 238. At the start of the reactor's operation, approximately eight-tenths of a plutonium atom will be formed for each atom of U 235 that is fissioned. The amount of plutonium increases during the lifetime of the reactor.

The reactor will have 24 control rods made of hafnium metal which was selected because it readily absorbs neutrons and thus can retard the atom splitting, heat-producing process.

Hafnium is obtained during the processing of zirconium, a metal used for structural purposes in reactor construction. Like zirconium, hafnium is highly resistant to corrosion in hot water under pressure.

The vessel which will hold the reactor will have an over-all height of 33 ft. It will be cylindrical in shape and will have an inside diameter of about 9 ft. Its walls will be almost 9 in. thick and will be made of carbon steel plates and forgings with ¼-in. stainless steel cladding. Total estimated weight of the reactor vessel will be about 500,000 lb.

The enriched uranium fuel will be made in the form of plates clad with a zirconium alloy. The natural uranium will be made into a cohesive mass and placed in zirconium alloy tubing.

The flow of extremely pure water, which serves both as moderator and coolant, will be 45,000 gal per min for three main coolant loops. Though four loops will be installed, only three will be required to produce the 60,000-kw minimum design power. The water will be under 2000 psi pressure with an average temperature of about 525 F.

The entire nuclear portion of the power plant will be housed in four steel containers which, in turn, are in concrete compartments partially below ground surface. The displayed scale model shows that from the outside the nuclear power plant does not look too different from a conventional power plant except for the absence of large stacks and fuel storage and handling facilities.

The turbine generator will operate at 1800 rpm, and the steam conditions at full load will be 545 psig without superheat. The turbine will be equipped with a moisture separator, and all turbine blades will be Stellite-faced on the leading edges wherever moisture content of the steam exceeds 6 per cent. These precautions are expected to minimize the effects of the wet steam on the life of the turbine parts.

On an electric distribution network the frequent changing needs of customers place special important requirements on the flexibility of the generating plants, and the Shippingport plant, including the reactor, has been designed to meet these requirements. The overall control of the plant, which plays an important part in accomplishing this, will emanate from a single control center and will feature ease and simplicity as necessities for safety and dependability.

The start-up and shut-down requirements of the Shippingport power station are somewhat improved over those of a conventional plant. The time required for the Shippingport station to reach its operating range after a "cold shut-down condition" will be approximately 3½ hr. Following an overnight shut-down, less than 1¾ hr will be required to reach full operation. The time necessary to perform these operations on conventional equipment of this size is 5½ hr and 2½ hr, respectively.

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Warning to Fussy Carburetors

PEOPLE attending the National Petroleum Assn. meeting recently saw a car without a carburetor—it uses a new "fuel injection" system.

The Petroleum Chemicals Division of the Du Pont Company equipped the Lincoln test car on display, one of the first passenger cars in America to be fitted with this system of fuel distribution. While new to passenger car engines, fuel injection has been used for years in aviation and diesel engines. The system is relatively simple. It consists of a pump which transfers fuel from the gasoline tank through a filter to a fuel injection pump, which in turn forces a spray of identical amounts of fuel through nozzles into each cylinder of the automobile.

Fuel injection equipment, still relatively expensive, may soon be used in some models of the higher priced automobiles. Automotive engineers have long thought there were advantages to fuel injection, but until the use of four-barrel carburetors the fuel injection parts had been too expensive to be competitive with carburetor parts.

Du Pont fuel injection tests, conducted as a service to refiners to determine what future gasoline requirements might be, proved some of the advantages to be

gained by using fuel injection. Included are better economy, more power, lower octane requirements, and freedom from vapor lock. The elimination of the carburetor may also allow designers to lower hoodlines.

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Pillar of Fire

DESPITE all the records of tornadoes throughout history, and the damage they have done, relatively little is known of their cause. Taking observations during the passage of a tornado is difficult, even if one is in the proper frame of mind to do so. The tornado's path is narrow and its passage swift, and the view from outside the danger area is obscured by the tornado cloud and debris. Few people have looked directly into the vortex of a tornado and survived to report what they saw. Considerable progress has been made, however, in determining the meteorological conditions responsible for tornadoes and in preparing useful forecasts of them.

Recent studies support an ancient theory abandoned about a hundred years ago. This theory—that a tornado is the effect of an electrified current of air—is consistent with our modern knowledge of lightning and electricity. Tornadoes are always associated with violent thunderstorms—one research project has been devoted to classifying electrical storms and tornadoes. It appears that there is considerable correlation between the height of the thunderheads and the intensity of the storm, and between the frequency of the lightning strokes and the danger of a tornado. Observations in the Great Plains region during the tornado season of 1954 revealed that when the strokes were as frequent as 14 per second, the typical funnel-shaped cloud of a tornado accompanied the storm.

After the Massachusetts tornado of 1953 had passed out to sea, the lightning strokes of the retreating storm line occurred at the rate of 10 to 20 per second; some of these lightning sparks were at least ten miles long. From the current and voltage known to exist in lightning strokes, it was estimated that the storm was generating 200 million kilowatts of power—equivalent to the rate of electric power generation of the entire United States, or to the average energy of an atom bomb every three minutes.

Both ancient and modern accounts of tornadoes frequently mention observations that strongly suggest the presence of electrical phenomena. The storms that produce tornadoes are accompanied by unusually intense lightning; brilliant St. Elmo's fire is sometimes seen beneath the tornado funnel; vegetation near its path is frequently burned and scorched as if it had been subjected to strong electric discharges; and a pungent odor of ozone is frequently reported.

The few people who have reported conditions inside the tornado tube say that it is filled with constant lightning, or that there is a brilliant luminous cloud or ball of fire in the axis. From Paris in 1806 came a report of a tornado "traversed from top to bottom by a tube as luminous as the moon." An observer in McKinney, Tex., in 1948, said that a tornado was "filled with a bright cloud, which shimmered like a fluorescent light."

The eclipse of the electrical theory can perhaps be traced to the Danish physicist, Oersted, who, in 1839, opposed the view of tornadoes carrying an electric current, because they did not act violently on the magnetic needle. This objection is not valid in the light of our present knowledge. Assuming that a current of 20 amp, generating 7500 kw, were flowing in a tornado about 100 yd in diameter, the flow of current per unit area would have too little magnetic effect on a compass needle to be observed.

Unlike the hurricane, which may last for a week and have a path several hundred miles wide, the tornado is usually only a few hundred yards in diameter, and its destructive path is, on the average, no more than 16 miles long. While hurricane winds may reach a velocity of 130 mph, tornadoes whirl at the rate of 300 mph, and their winds may even exceed the speed of sound, although there is no way to measure them. It is reported that within the funnel it is silent, although on the edge of the storm the sound is like several jet planes taking off.

Industrial Bulletin, Arthur D. Little, Inc. July, 1955

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Breeding Paper

THE PAPER industry is trying to make a better tree as one part of new research aimed at raw-materials improvement.

To further this objective, the Institute of Paper Chemistry (Appleton, Wis.) has hired a geneticist and an assistant, allocated funds to support their studies. Their task: to discover whether genetics can be used to control the yield and composition of wood fibers for pulping.

It's known that plant varieties containing extra sets of genes (polyploids) differ markedly from normal diploid forms. One Swedish aspen (probably a triploid), for example, is substantially larger than other aspens, gives appreciably more fibers per acre of woodland.

The geneticists will work with natural polyploids such as this, also try to produce new families of artificial polyploids. Colchicine, high temperatures and possibly radiation are able to convert diploids to polyploids. Researchers will soon try to determine whether such artificial forms can reproduce in the forest.

Genes that control important pulping characteristics (density, penetrability, cellulose content, resistance to disease, etc.) will also come in for investigation. If the work is successful, pulpers will eventually see hardwood logs of optimum composition[1] for processing.

Another intriguing possibility is that cellulose may be advantageously modified. A pulp made of cellulose containing about 2 per cent carboxymethylcellulose (CMC) can reportedly be beaten in one-sixth the usual time; paper made from this pulp, moreover, is said to have double the bursting strength, $1^1/_2$ times the tensile strength, and 13 times more folding strength than paper from comparable untreated pulp. Tear strength, on the other hand, appears to suffer somewhat.

If the method can be economically applied in pulping plants, it will permit such plentiful woods as Douglas fir and Southern pine to be upgraded to approach the quality of scarce Western hemlock and Northern spruce.

Chemical Week, July 30, 1955

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Good News for Truckers

A BLOWOUT-proof tire for trucks and buses that will outlast the vehicle is now a reality, thanks to a successful research program conducted at the Newburgh Works of U. S. Steel's American Steel and Wire Division in Cleveland, Ohio. Here they have developed a high tensile strength, specially stranded wire for reinforcing cord.

Not to be confused with bead wire, the new cord wire is built into the plies, two to four of which are formed in the carcass of the tire.

With a tensile strength of 375,000 to 425,000 psi, far in excess of any available fabric cord, wire makes possible a safer, stronger tire with a thinner cross-section. This in turn provides greater resiliency and reduces accumulation of heat. The metal-core ply also eliminates casing stretch.

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[1] Hardwoods vary in content roughly as follows: a-cellulose, 43 to 55 per cent; lignin, 17 to 24 per cent; pentosans, 19 to 22 per cent; alcohol-benzene extractables, 1 to 3 per cent.

ACR Notes

Administrative Committee on Research

A Thousand Ages

By Owen W. Ellis[1]

TO ANYONE interested in the prehistory of the human race, the book *Prehistoric Men* by Robert J. Braidwood, of the University of Chicago, should be most welcome.

One of the most surprising things which he records is the fact that "by half a million years ago, just after the first glaciation was finished, men began making tools according to a certain set tradition." As a matter of fact, three such traditions were established by this time; which is the oldest is unknown.

Two of the great traditions of toolmaking were common throughout Europe, Africa, southwest Asia and India, while the other was confined to southern and eastern Asia, from northwestern India through Java and Burma into China, though there was some overlapping at the frontiers of the two main areas of distribution.

It should be mentioned that the tool kit of the far eastern peoples seems to have included implements for doing just as many different jobs as did that of the westerners. In view of the very low density of population, it is amazing that knowledge of the techniques of toolmaking should have spread so widely in each of the areas of distribution. However, the half-million years which elapsed was, in all probability, time enough indeed for this to happen.

As might be expected, improvements, in course of time, were made both in the design and fabrication of the tools in each tradition. In spite of this, the expert today can, without too much difficulty, assign the tools he unearths to one or another of these traditions.

The point I would like to make here is that standardization in the design and fabrication of tools was already in effect 500,000 years ago and this apparently without the benefit of such organizations as the American Society for Testing Materials.

The question might well be asked whether tradition and standardization might not have accounted for the slow progress in the development of tool design and fabrication. We know well enough, however, that other factors had an important bearing upon progress in these early ages—the question, therefore, can be answered in the negative.

But, were the question put today in a slightly different form—"Are tradition and standardization impeding development in your particular line of work?"—the answer in many cases would have to be "Yes." Even were the person to whom the question was put to answer in the negative, a competent and unbiased investigator would, in all too many cases, have to answer "Without a doubt, YES!"

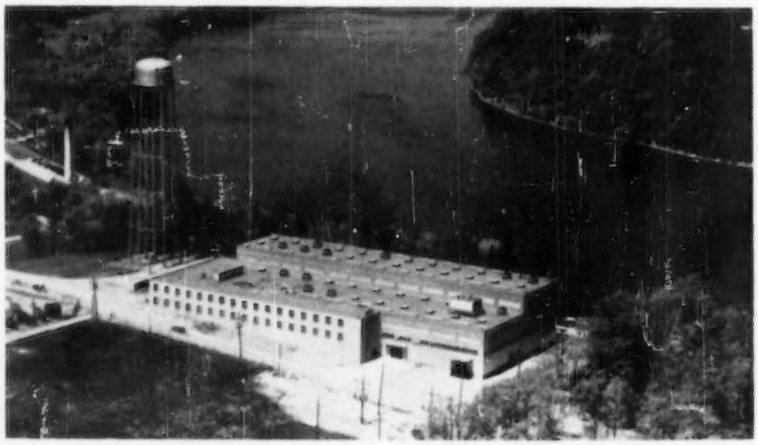
Tradition and standardization of the type we have referred to above should have no place in affairs today. Least of all should it have a place in the committees of such organizations as the American Society for Testing Materials—not that there is the slightest evidence of such an unhappy situation.

One wonders, nevertheless, whether there is an awareness in ASTM technical committees of the "fire" that might result if a "live coal"—*an unsolved problem*, maybe—were brought to the attention of the Administrative Committee on Research at the opportune moment, seeing that it is the function of this committee to fan just such "coals" into flame. Now, when we view the accomplishments of prehistoric men, we realize that "a thousand ages" indeed are "like an evening gone." And an industry today, if it is so steeped in tradition and so standardized that it can claim to have no PROBLEMS TO SOLVE, can be gone in much less than evening.

Look out, therefore, for *any* "live coals" that might be fanned into a "flame!" And, while doing so, find out how the Administrative Committee on Research can help in the fanning!

[1] Recently retired from Ontario Research Foundation and from ASTM Administrative Committee on Research.

"Renaissance" of Metallurgy and Ceramics



Dramatic proof of the growing importance of metallurgy and ceramics as sciences instead of industrial arts is General Electric Company's investment in a new Metals and Ceramics Building at the GE Research Laboratory.

Addition in August of this year of the new $5 million building to existing facilities at The Knolls, on the Mohawk River near Schenectady, gives GE scientists one of the world's finest laboratories for seeking new knowledge and translating what they learn into new materials and processes for American industry.

ISO 28, on Petroleum Products Meets in London

Delegations from the national standardizing bodies of Belgium, Denmark, France, India, Italy, Japan, the Netherlands, Sweden, United Kingdom, and the United States attended the meeting of Technical Committee 28 on Petroleum Products of the International Organization for Standardization held May 23 and 24 in London.

L. C. Burroughs, Shell Oil Co., New York, was leader of the American delegation representing the American Standards Assn. W. T. Gunn, American Petroleum Inst., attended the meeting as secretary of the committee. Other U. S. delegates were: E. L. Baldeschwieler, Esso Research and Engineering Co.; E. S. Brown, California-Texas Oil Co., Ltd.; H. W. Field, The Atlantic Refining Co.; G. F. Hussey, Jr., Managing Director, American Standards Assn.; A. L. Lyman, California Research Corp.; K. G. Mackenzie, Consultant; A. E. Miller, Sinclair Refining Co.; Norman Thompson, Sun Oil Co.

Technical Committee 28 has for its stated objective "the development of international agreement on standard methods for testing and measuring petroleum products."

"American technology can feel proud of the fact that all three of the proposals of the American Standards Association were unanimously accepted by those present at the meeting," Mr. Burroughs commented after the meeting. "These proposals were that the ASTM motor and research methods for determination of octane number of motor fuels and the ASTM-IP Petroleum Measurement Tables be put forward for recognition as international recommendations. The American delegation was happy to have these proposals approved by the technical committee."

This meeting was a milestone on the road of progress. The producers and consumers of petroleum products in the United States recognize the advantage of a uniform system of testing petroleum products. This first step toward agreement on international recommendations, based as they are on three American Standards, was felt to be an encouraging step. The committee adopted a program with the objective of finding acceptable methods for determination of (1) flash point; (2) specific gravity; (3) density; (4) viscosity; and (5) tetraethyllead content of motor gasolines.

Some of the delegates indicated a desire for more frequent meetings. The secretary replied by promising to call a meeting as often as there is justification for it. If the work before the several countries is carried out promptly, a meeting will be called in Paris (France) in 1957.

ISO 61 on Plastics Meets in Paris

THE FIFTH international meeting of Technical Committee 61 on Plastics of the International Organization for Standardization was held in Paris, July 8 to 13. The U. S. holds the secretariat for this committee and Gordon Kline of the National Bureau of Standards served as chairman of the meeting. Serving as co-chairman was J. Duval of the French Standards Organization (AFNOR). Leader of the U. S. delegation was Robert Burns of the National Research Council. N. A. Skow, Synthane Corp., served as secretary assisted by Mme. Charreyron of the Centre d'Etudes des Matieres Plastiques. Other members of the U. S. delegation who attended were: C. H. Adams, Monsanto Chemical Co.; William A. Franta, E. I. du Pont de Nemours & Co.; J. W. McNair, American Standards Assn.; R. R. Winans, New York Naval Shipyard; R. K. Witt, Johns Hopkins University; E. Y. Wolford, Koppers Co.; and E. E. Ziegler, Dow Chemical Co.

Altogether, seventy-two delegates and experts representing the following countries were present: Belgium, Czechoslovakia, France, Germany, India, Italy, Netherlands, Sweden, Switzerland, United Kingdom, and United States.

Notable progress was made in the standardization of nomenclature and testing methods for use in international trade by the eight Working Groups of the committee. Ten Draft Proposals were approved for circulation to the fourteen participating and sixteen observer member countries of ISO/TC61. These proposals dealt with a list of equivalent terms pertaining to plastics in English and French, test methods for the determination of flexural properties of plastics, melt flow index of polyethylene, bulk factor of molding compounds, qualitative detection of free ammonia in phenolic moldings, amount of styrene in polystyrene, viscosity of polyvinyl chloride solutions, resistance of plastics to chemicals, volatility of plasticizers from plastics, and migration of plasticizers. Four Draft ISO Proposals that had been reviewed by the ISO/TC61 members prior to the meeting were approved for circulation by the ISO Secretariat (Geneva) to all ISO member countries for consideration for advancement to the status of ISO Recommendations: methods of test for methanol soluble matter of polystyrene, free phenols in phenolic moldings, quantitative determination of free ammonia in phenolic moldings, and boiling water absorption of plastics. Five Draft ISO Recommendations had previously been sent to Geneva for distribution, dealing with the determination of percentage acetone-soluble matter in phenolic moldings, apparent density of molding materials that (1) can and (2) cannot be poured from a funnel, water absorption of plastics, and temperature of deflection under load (heat distortion temperature). Further action on these methods awaits the results of the international balloting.

Two new Working Groups met for the first time at the Paris meeting. These groups will deal with the preparation of test specimens (leader is Earl Ziegler, U.S., Dow Chemical Co.) and electrical properties (leader is Mr. Aeschlimann, Switzerland). The committee voted to cooperate closely with Technical Committee 15 of the International Electrotechnical Commission (IEC/TC15) in work on the development of international electrical tests for plastics. A similar resolution was adopted relative to cooperation with ISO/TC58/C6 in the preparation of international specifications for plastic pipe and fittings. ISO/TC61 also voted to revise its scope to include specifications as well as nomenclature and test methods; this action must be approved by the ISO Council.

IUPAC Means International Cooperation in Chemistry

REPORTS from the Passport Division of the U. S. State Department reveal that an unprecedented number of Americans are going abroad. There is evidence that these travelers representing a growing factor in international understanding, often combine business with pleasure and establish or renew business contacts or attend scientific or technical meetings in other countries.

This year more Americans than usual

attended the Conference of the International Union of Pure and Applied Chemistry (IUPAC) held in Zurich, Switzerland, from July 20 to 28. For the first time in the history of the Union, the U. S. has an elected representative on the IUPAC executive committee, W. Albert Noyes, past president of the American Chemical Society and currently editor of two of its journals.

Of particular interest to ASTM are activities of three of the six sections of IUPAC each of which is subdivided further into commissions. Under the Section on Physical Chemistry are commissions on physicochemical data and standards, on radioactivity, and on molecular spectra. The latter commission, which is newly established, will endeavor to bring about international cooperation in the field of molecular spectra as regards presentation of spectral data in the form of charts, tables, punch cards, etc.

A longtime member of several ASTM committees, Fred D. Tuemmler of Shell Development Co., was elected secretary of the Analytical Section. Chairman of the Section is I. M. Kolthoff, Professor of Analytical Chemistry of the University of Minnesota. The commission on Terminology and Expression of Analytical Results, under Prof. Robert J. Forbes of the Netherlands, has brought to completion a draft or format of an analytical method; the Commission is cooperating with ISO/TC47 (Chemistry) in this project to develop a uniform recommendation on the writing of commercial test methods for national and international use.

Also under the Analytical Section is the Commission on Microchemical Techniques which has recently completed a survey of such techniques in 25 countries with a view to ascertaining profitable subjects for standardization. Work is starting on the preparation of international standards of microchemical apparatus and listing of preferred notations (units) of measurement with special reference to microtechniques.

The Section of Applied Chemistry is organized into Divisions under which are several commissions. The Division of Fats and Oils sponsored the publication in 1954 by IUPAC of the monograph entitled "Standard Methods for the Analysis of Oils and Fats." Methods of analysis now under investigation include determination of free alkali in soaps, rosin content of soaps, sediments in linseed oil, acidity in seed extracts, color of oils by spectrophotometric methods, and titration of glycerol.

Also under the Applied-Chemistry Section, is the Division of Plastics and High Polymers under the chairmanship of R. Hovinck of the Netherlands; vice-chairman of the Division is long-active ASTM member Gordon Kline of the National Bureau of Standards who also is chairman of ISO/TC61 on Plastics. The division is working on identification tests of plastics and high polymers, classification of industrial materials, glossary of preferred terms and definitions for commercially important materials, and abbreviated designations for use in technical literature.

Other Divisions of the Applied Chemistry Section are concerned with foods, crop protection, toxicology, industrial hygiene, organic coatings and water, sewage and industrial wastes.

A more complete report on the IUPAC meeting appears in *Chemical and Engineering News*, Vol. 33, No. 35, August 29, 1955.

ASTM Standards Approved by American Standards Association

According to the annual report of the American Standards Association, there are now 1440 American Standards in use in the United States. Of this number 152 were approved in 1954; 64 were new standards and 88 were revisions. Following are the 22 ASTM Standards which have been approved during 1954 as new American Standards:

Construction

A1.17-1954 (ASTM C 266 – 51 T)	Method of Test for Time of Setting of Hydraulic Cement by Gillmore Needles
A100.1-1954 (ASTM C 32 – 50)	Specifications for Sewer Brick (Made from Clay or Shale)
A101.1-1954 (ASTM C 126 – 52 T)	Specifications for Ceramic Glazed Structural Clay Facing Tile, Facing Brick, and Solid Masonry Units
A102.1-1954 (ASTM C 159 – 51)	Specifications for Vitrified Filter Block for Trickling Filters
A103.1-1954 (ASTM C 279 – 54)	Specifications for Chemical-Resistant Masonry Units
A104.1-1954 (ASTM C 43 – 50)	Definitions of Terms Relating to Structural Clay Tile
A105.1-1954 (ASTM C 52 – 41)	Specifications for Gypsum Partition Tile or Block
A106.1-1954 (ASTM C 211 – 50)	Specifications for Standard Strength Perforated Clay Pipe
A107.1-1954 (ASTM C 35 – 53 T)	Specifications for Inorganic Aggregates for Use in Interior Plaster

Electrical

C8.22-1954 (ASTM D 470 – 52 T)	Methods of Testing Rubber-Insulated Wire and Cable
C8.23-1954 (ASTM D 755 – 52 T)	Specifications for Performance Synthetic Rubber Compound for Insulated Wire and Cable
C8.24-1954 (ASTM D 754 – 52 T)	Specifications for Heat-Resisting Synthetic Rubber Compound for Insulated Wire and Cable
C8.25-1954 (ASTM D 532 – 49)	Specifications for Rubber Sheath Compound for Electrical Insulated Cords and Cables
C8.26-1954 (ASTM D 353 – 52 T)	Specifications for Performance Rubber Compound for Insulated Wire and Cable
C8.27-1954 (ASTM D 469 – 52 T)	Specifications for Heat-Resisting Rubber Compound for Insulated Wire and Cable
C8.28-1954 (ASTM D 866 – 46 T)	Specifications for GR-S Synthetic Rubber Sheath Compound for Electrical Insulated Cords and Cables
C8.29-1954 (ASTM D 574 – 46 T)	Specifications for Ozone-Resistant Type Insulation for Insulated Wire and Cable
C8.30-1954 (ASTM D 734 – 50 T)	Specifications for Polyvinyl Insulating Compound for Insulated Wire and Cable
C8.31-1954 (ASTM D 753 – 49)	Specifications for GR-M Polychloroprene Sheath Compound for Electrical Insulated Cords and Cables Where Extreme Abrasion Resistance Is Not Required
C8.32-1954 (ASTM D 752 – 49 T)	Specifications for GR-M Polychloroprene Sheath Compound for Electrical Insulated Cords and Cables
C8.33-1954 (ASTM D 1047 – 49 T)	Specifications for Thermoplastic Vinyl Polymer Sheath Compound for Electrical Insulated Cords and Cables

Miscellaneous

Z71.1-1954 (ASTM E 1 – 53)	Specifications for Thermometers

ASTM to Participate in Nuclear Congress

Cleveland Meeting to Include Atomic Exposition

ASTM will join with 25 other engineering, technical, and scientific groups in taking the first nationwide, full-scale look at atomic energy at the Nuclear Engineering and Science Congress and Atomic Exposition to be held at Cleveland, Ohio, December 12–16, 1955. The Exposition, displaying everything from models of the atom to operating nuclear reactors, will be opened December 10. Basic objective of the Congress is to launch a continuing program of interchange of information on the developing applications of nuclear science by the engineer and the scientist for vital national benefits involving industry, agriculture, medicine, and the public welfare.

Two papers sponsored by ASTM through Committee E-10 on Radioactive Isotopes will be presented at a session on radioactive isotopes and tracer techniques on Monday morning, December 12. John R. Bradford, a member of Committee E-10 and Dean of Engineering at Texas Technological Institute, represented the Society on the program committee.

In his paper, "The Use of Radioisotopes in Material Testing," J. L. Kuranz, Nuclear Instrument and Chemical Corp., will discuss the application of radioisotopes as analytical tools. The following techniques will be described as they apply in the field of materials testing: isotope dilution and derivative method for rapid, accurate quality control; motor oil, gasoline, and other engine analysis with radioactive piston rings; precision determination of hydrogen and carbon in liquid petroleum products using beta absorption; density and thickness control with beta and gamma gages; and determination of tracer amount of impurities using neutron activation analysis. In addition to summarizing the performance of isotopes as testing tools, some discussion will be given on facilities required for the application described.

C. W. Wallhausen, Vice President, United States Radium Corp., will speak on "Use of Self-Luminous Materials Employing Radioisotopes." Self-luminous compounds consist of a phosphor mixed with or used in conjunction with a radioactive element or compound.

Sessions

Safety and Site Selection for Reactors (6 papers)
Safety in Reactor Construction (6 papers)
Radiation Hazards (6 papers)
Instrumentation for Reactors (6 papers)
Reactor Control and Instrumentation (6 papers)
Proposed Reactor Types (6 papers)
Reactor Operation and Proposed Designs (6 papers)
Reactor Technology—Heat Transfer (6 papers)
Reactor Technology—Liquid Metals (12 papers)
Heat Transfer and Fluid Flow (6 papers)
Reactor and Coolant Technology (6 papers)
Reactor Technology—Corrosion (6 papers)
Reactor Technology—Design and Construction (6 papers)
Nuclear Characteristics of Fuel Assemblies (6 papers)
Radiation Damage to Structural Materials (6 papers)
Reactor Technology—Fabrication (6 papers)
Reactor Technology—Metallurgy and Alloys (6 papers)
Reactor Materials (12 papers)
Reactor Materials and Design (6 papers)
Materials and Metallurgy (6 papers)
Economics in Reactor Design (6 papers)
Catalysis and Chemical Reactions (6 papers)
Chemical Processing and Separation (12 papers)
Research Reactors and Radiation Laboratories (6 papers)
Radioisotopes and Tracer Techniques (6 papers)
Accelerators (6 papers)
Removal of Fission Products from Aqueous Solutions (6 papers)
Detection and Monitoring of Nuclear Debris in Water (6 papers)
Disposal of Radioactive Wastes (6 papers)
Pollution Aspects of Radioactive Fallout (5 papers)
Chemical Separations (6 papers)
Nuclear Properties (6 papers)
Legal and Insurance Problems (6 papers)
Educational Requirements for Nuclear Engineering (5 papers)
Chemistry of Solutions (7 papers)
Recovering Fission Products (6 papers)
Reactor Analysis Techniques (6 papers)
Reviews of Literature in Atomic Energy Fields (6 papers)
Radiation Effects on Polymerization and Chemical Reactions (6 papers)
Uranium Geology (22 papers)
Dissolution and Chemical Processing (5 papers)
Reactor Technology (5 papers)
Radiochemistry (6 papers)
General (12 papers)

Sponsors

Engineers Joint Council
- American Society of Civil Engineers
- American Institute of Mining and Metallurgical Engineers
- The American Society of Mechanical Engineers
- American Water Works Assn.
- American Institute of Electrical Engineers
- The Society of Naval Architects and Marine Engineers
- American Society for Engineering Education
- American Society of Refrigerating Engineers
- American Institute of Chemical Engineers
- American Institute of Industrial Engineers

American Chemical Society
American Institute of Physics
Institute of Radio Engineers
American Nuclear Society
American Geological Institute
- Mineralogical Society of America
- Society of Exploration Geophysicists
- Society of Economic Geologists and Geological Society of America
- American Assn. of Petroleum Geologists
- Society of Economic Paleontologists and Mineralogists

American Society for Metals
American Society for Testing Materials
American Rocket Society
Institute of Aeronautical Sciences
Atomic Industrial Forum
Society of Automotive Engineers
Cleveland Engineering Society
Cleveland Technical Societies Council

Phosphors that are used include zinc- or zinc-cadmium sulfides, silicates and tungstates, the first being the most efficient. Isotopes for activation of phosphors include polonium, actinium, C_{14}, Pm_{147}, Tl_{204}, Kr_{85}, Sr_{90}, Co_{60}, Cs_{137} and others.

Other sessions of particular interest to ASTM are related to corrosion, radiation damage to structural materials, metallurgy and alloys, and reactor materials.

Major Cooperative Effort

The Congress, coordinated by the Engineers Joint Council, represents the biggest single project ever undertaken by the combined engineering and scientific societies of the nation. Altogether, nearly 300 papers describing the latest developments in nuclear engineering and science will be presented in 50 technical sessions spread over the five-day period. In addition to the support of the societies, the Congress is actively supported by private enterprise and Government. The sponsoring groups and cooperating societies involve half a million engineers and scientists representing such apparently diverse fields as mining, metallurgy, sanitation, water supply, aviation, automobile manufacture, rockets, architecture, ships, road construction, and city planning.

Talks on the theory and application of nuclear energy will be augmented in tangible form in the concurrent Atomic Exposition, sponsored by the American Institute of Chemical Engineers, which will display the actual tools of atomic energy in the form of full-size and model reactors, components, equipment, materials, and services in the atom power field. This Exposition will include many initial displays of nuclear equipment and will be open to the public on December 10 and 11.

Advance programs listing all papers which have been accepted for presentation will be available about the first of November. Copies of the program may be obtained from any of the sponsoring Societies and from the Engineers Joint Council at 29 W. 39th St., New York 18, N. Y. Members of ASTM may obtain copies from Headquarters, 1916 Race St., Philadelphia 3, Pa. The program will contain information about advance registration and hotel reservations.

New National Bureau of Standards Standard Samples

Two new standard samples have been added to the list of more than 200 standard samples of certified composition which the Bureau issues for use in checking the accuracy of analytical procedures used in industrial and research laboratories.

Standard Sample No. 3, white (chilled) iron, is available with a provisional certificate of analysis for the following constituents: Total C 2.26; graphite, nil; Mn 0.35; P 0.120; S 0.090; Si 0.99; Cu 0.128; Cr 0.050; Ni 0.018; V 0.007; Mo 0.005. The price of this standard is $4.25 per 125-g unit.

Standard Sample No. 177, portland cement, is being issued with a provisional certificate of analysis for the following constituents: SiO_2 21.90; Al_2O_3 5.28; Fe_2O_3 2.38; TiO_2 0.27; P_2O_5 0.05; CaO 64.25; SrO 0.05; MgO 2.42; SO_3 1.59; Mn_2O_3 0.05; Na_2O 0.14; K_2O 0.56; loss on ignition 1.14. The price of this standard is $4.25 per unit which consists of three 5-g portions sealed in glass vials to insure stability. Orders should be addressed to the National Bureau of Standards, Washington 25, D. C.

New Electronics Presents Challenge for Materials Engineers

SPEAKING at the Symposium on Electronic Materials and Components held in Philadelphia on June 2 and 3, A. E. Middleton of P. R. Mallory and Co., asserted that we can no longer look on electronics as an engineering field divorced from materials engineering; indeed, the future achievement of objectives such as development of production and business automation, subminiaturization, long-life equipment and many new commercial products is a materials engineering job of vast proportions. Major challenges include developing basic knowledge about the relationship between electrical, chemical, optical, dielectrical, and magnetic properties of materials. Purification of solids to better than 1 part in 100 million as is required for germanium and silicon offers a special challenge.

The symposium sponsored jointly by the American Institute of Electrical Engineers and the Institute of Radio Engineers covered four major areas—magnetic materials, dielectric materials, insulating materials, and application of materials to components. The first session was concerned with powdered iron cores and various polycrystalline ceramics—materials which because of their unusual combination of dielectric and magnetic properties present exceptional opportunity for design innovations. The session on dielectric materials might well have been titled "capacitor materials" since the papers were concerned with materials such as magnesium oxide, mica, and porous tantalum compositions used in capacitors. Subjects covered in the insulating materials session included surface resistivity at high humidity, water-repellent materials, moisture resistance and dielectric breakdown, copper clad insulating material and fluorocarbon and silicone insulating materials.

ASTM activity in materials for electronics is considerable. Long-established committees active in this area are B-1 on Electrical Conductors, A-6 on Magnetic Properties, and D-9 on Electrical Insulating Materials. Though a relative newcomer in the area, Committee F-1 on Materials for Electron Tubes and Semiconductor Devices, as Subcommittee VIII of Committee B-4 has already distinguished itself by solving some of the very knotty problems relating to electron tube cathodes. (BULLETIN—July 1955, pp. 36 and 49).

Role of Chemistry in Electronics

Closely related to the subject of the IRE-AIEE Symposium was an article by F. J. Biondi in the July-August issue of *Research and Engineering*, entitled "Challenge to Chemical Research." Mr. Biondi, of the Bell Telephone Laboratories and vice-chairman of Committee F-1, points out in the article that the electronics industry is dependent on the chemical industry for its raw materials and it is vitally important for the two industries to understand each other. The role of the chemist in preparing most electronic materials is pivotal because chemical methods for preparation, purification, and analysis are necessary steps between the basic raw material and the final fabrication of the materials into electronic components. But in order to understand the materials problems in electronics, the chemist must work with the electronics specialist in establishing standard methods of test so as to control the quality of the materials for electronic use.

Mr. Biondi points out further that this cooperation between the chemical and the electronics industries can be and is being fostered through the industry-wide committees in ASTM where both the producers and the consumers of materials can get together and come to a common understanding. It is desirable that this kind of cooperative effort be expanded so that those areas in electronic materials development where chemistry and electronics rub shoulders will be adequately covered.

Canada's National Research Council

THOUGH similar in some respects to our own NRC,[1] Canada's National Research Council is much broader in scope, serving as the centralized research establishment for the Canadian Government. The Canadian NRC might be considered the equivalent in Canada of the combined U. S. research establishments of the National Bureau of Standards, and parts of the Departments of Defense and Agriculture together with the advisory services of the National Research Council of the National Academy of Sciences.

In 1916, Canada recognized the importance of organized research on a national basis by establishing an Advisory Council for the planning and integration of research, the organization of cooperative investigations, post-graduate training of research workers and the prosecution of research through grants-in-aid to university professors. With the passing by Parliament of the Research Council Act in 1924, Canada not only endorsed the principle of research on a national basis but provided financial support to establish, staff, and maintain research facilities.

As in the U. S., the exigencies of World War I emphasized the need for a national effort which greatly accelerated research and development in Canada. Following the war, both countries slipped back for a time before establishing this wartime research and development effort on a permanently supported basis. For a time the NRC operated with temporary facilities, but the usefulness of the venture proved so apparent that in 1929–30, the Government provided funds for permanent laboratories.

The National Research Building on Sussex Street in Ottawa was opened in 1932, and in 1939 construction was begun on the aerodynamics building on a 130-acre site adjacent to the Ottawa Air Station. Construction of other buildings on this site soon followed, providing facilities for research on engines, gas and oil, hydraulics, structures, engineering, low temperature studies, and high-speed aerodynamics.

In 1953 construction was completed on applied chemistry laboratories, a thermodynamics building, offices, and laboratories for the Divisic of Building Research and an extensive laboratory building for the Division of Radio and Electrical Engineering.

The Atomic Energy Project at Chalk River, Ont., also was administered by the National Research Council from 1947 to 1952 when it was transferred to the new Crown Company, Atomic Energy of Canada, Ltd. The project continues to be operated under policies laid down by the Atomic Energy Control Board.

Revenue for the Council is provided by an annual Government appropriation of about $15 millions and, in addition, the Council collects about $1 million annually in fees for services.

Not only does the National Research Council support fundamental research by investigations in its own laboratories, it also provides funds for graduate study in universities. Through this program, some 1800 science graduates have been enabled to gain advanced training in scientific research, thus providing Canada with a valuable asset in trained scientific manpower.

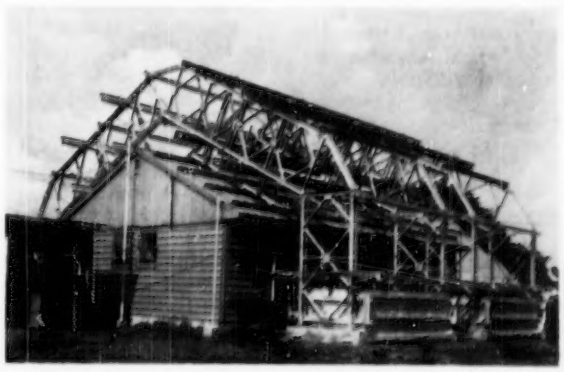
The Council serves as a consulting body for Canadian industry, and in order to carry out this and other functions, the laboratories maintain a staff of highly trained and thoroughly competent research workers in each of the major fields of the natural sciences. These teams of investigators devote their attention chiefly to the study of long-term applied research projects which are mostly of a kind that no other Canadian organization is equipped to do.

The Council receives the helpful advice and guidance of many distinguished scientists from industry and the universities who, without fee, serve on committees established to advise on the conduct and direction of research in many broad fields such as animal science, corrosion research, dental studies, food preservation, forest fire protection, grain research, radio science, soil and snow mechanics, and many more.

In addition to the extensive laboratory facilities at Ottawa, the council maintains two regional laboratories. These include the Prairie Regional Laboratory located on the campus of the University of Saskatchewan opened in 1948, and the Maritime Regional Laboratory on Dalhousie University campus at Halifax, N. S.

The Science Divisions

The science divisions are concerned both with applied and fundamental problems. Applied science studies have been carried out on such subjects as transport and storage of frozen foods, utilization of various agricul-



Test by Canada's NRC of a full-scale house under simulated wind and snow loads.

[1] The National Research Council [U. S.] ASTM BULLETIN No. 196, February, 1954 p. 18.

tural products, treatment of crop diseases, etc., in the **Biology Division.** Additional agricultural studies are carried out at the **Prairie Regional.**

Of special interest to ASTM is the work of the **Applied Chemistry Division** which is engaged in a number of projects involving engineering materials. Investigations of corrosion inhibitors for metals in water and glycol antifreeze systems are continuing. Development work is in progress on production of zirconium by the Kroll process and of high-purity germanium crystals. Studies are being carried out on factors affecting soiling characteristics of textile materials. Some other projects are concerned with use of radioactive tracers, extenders and reinforcing agents for rubber, and development of special purpose adhesives.

In the **Division of Pure Physics,** research includes studies of absorption spectra of certain free radicals, Raman spectroscopy of gases, cosmic rays, behavior of metals at low temperatures, upper atmosphere, nuclear structure and X-ray diffraction. Projects in the **Division of Applied Physics** are concerned with accurate calibration of surveyors tapes, use of interferometry for precise length measurements, aerial triangulation, photometric standards, cobalt beam therapy unit measurements, radar altimeter and many others.

Other divisions cover medical research and pure chemistry.

Engineering Laboratories

Of particular interest in connection with ASTM work are the activities of the three divisions concerned with engineering.

The Division of Building Research has its administrative offices and some of its laboratory facilities at the Building Research Center on the Montreal Road, about four miles east of the center of Ottawa, which was completed and occupied in 1953.

The Division continues to operate Canada's only sound chamber for acoustical research in relation to buildings. Its work in paint research continues to be carried out in the Applied Chemistry Building at Ottawa, and in this field, a long term program has been developed.

Studies on thermal performance of walls in cold weather are continuing at the Prairie Regional facility at Saskatoon. Other problems relating to building in the far north are studied at Churchill and at the Permafrost Research Station at Norman Wells, N.W.T. Canada's first snow and ice laboratory was recently completed and is located in one of the new buildings in Ottawa.

One of the main contributions of the Division in recent years has been an extensive revision of the National Building Code. It is anticipated that the revised document will greatly facilitate the development of uniformity of building regulations across Canada.

Within the Division of Building Research, the council operates the Canadian Government Specifications Board which prepares specifications on a wide variety of industrial fields primarily for Government use. There are about 600 specifications in current use.

The Division of Mechanical Engineering concerns itself with four broad subjects—aerodynamics, hydrodynamics, thermodynamics and mechanics. In aerodynamics, the emphasis has shifted toward the transonic and supersonic speed range, reflecting a corresponding change in the Canadian aircraft industry. Two high-speed wind tunnels have been in use in investigations of aircraft and missile models over a speed range from subsonic to Mach number 2.5 (2.5 times the speed of sound).

The thermodynamics group has been engaged in major studies of gas turbines with particular emphasis on railway applications. Jet engines are also being investigated by this group.

The St. Lawrence Seaway project has been of major interest to the hydrodynamics group and the design of locks is a subject of active investigation. Testing of ship models in cooperation with the Navy has also occupied the attention of the staff.

The Radio and Electrical Engineering Division has been principally engaged in defense projects and, in addition, a variety of work comprising chiefly dielectric research, electron tube research, electromedical research, electrical engineering and electronic controls, radio astronomy, radio wave propagation, antenna development, and application of radar and microwave techniques to navigational problems.

The division is carrying out numerous and important investigations of various electronic systems such as microwave position fixing equipment, and other aids to navigation, as well as wired television. Of particular interest to materials engineers are the studies of this division relating to properties of materials. The study of currents flowing in insulating materials of commercial importance is of practical interest as well as an addition to fundamental knowledge. Theoretical and experimental studies of semiconductors are providing information useful both in design and in application of semiconductor devices.

A 1.2 million volt impulse generator is frequently used at the request of Canadian manufacturers of electrical equipment to test their products.

The division has developed a high resolution mass spectrometer which is particularly suitable for the study of gases evolved within electron tubes. The division is also responsible for maintaining Canada's primary standard of frequency which is kept in specially conditioned rooms for highest accuracy.

Service Groups

The Council maintains a good library as a service not only to its staff but to various branches of the Government which do not have such facilities. The library contains about 200,000 books and pamphlets in its central location in addition to numerous other materials in its branches. A reference and bibliographical service is furnished.

The technical information services assist Canadian industry by providing scientific and technical data about industrial processes, equipment, and so on. Inquiries have been running at the rate of about 8000 per year. Technical information services are becoming of increasing importance since, without them, it is almost impossible for industry to keep up with the sixty million pages of scientific and technical material published annually.

Cooperation with ASTM

The Canadian National Research Council, as the focal point for technical activities in Canada, has many interests in the area of engineering materials. Twenty-seven ASTM technical committees have representation from staff members of the Council. There are 28 individual members of the society from the Canadian NRC, providing ample evidence of widespread interest and excellent technical support in the NRC of the Society's work. Several hold important offices on technical committees, an outstanding example being R. F. Legget, Director of the Division of Building Research of the NRC and chairman of ASTM Committee E-6 on Methods of Testing Building Constructions.

If Canada has anything to say about it, and she certainly does, the *American* in ASTM definitely includes Canada.

The Testing of Cements for Inherent Strength*

By Myron A. Swayze

Longstanding tension briquet fails to indicate true strengths because of stress inequalities. Use of 2-in. cubes for compression testing is recommended.

THIS paper traces the history of strength tests on cement from the earliest recorded data on the subject up to the present time. At the outset, it should be emphasized that the word "inherent" is an essential part of the title. Cement is the only major building material which is not in itself a finished product. While its manufacture is closely controlled by experts, its use is frequently in the hands of semi-skilled or even common laborers who frequently have little realization of the effects of proportions, water control, and manipulations on the ultimate strength of their product, concrete.

The testing of cement for strength must be done under rigidly controlled conditions of mixing, molding, curing and breaking of specimens, if the testing agencies are to agree upon the potential strength of cement. Further, the test method should simulate, insofar as possible, the average conditions under which the cement is used, and the results reflect those properties in which engineers and designers are interested.

After the invention of portland cement by Joseph Aspdin in 1824, there seems to have been a lapse of some 20 yr before any real effort was made to devise a strength test for it. There are a few accounts of bricks being laid in neat cement in corbel fashion projecting from a vertical wall. One brick was laid each day, until the cantilevered weight finally broke the bond and the assembly toppled. Some brick beams were also tested, but no data concerning bond or tensile strength were reported.

The first systematic tests, as described by A. C. Davis,[1] were compression tests conducted in 1848, primarily to demonstrate the superiority of portland cement over Roman cement. The test specimens were 9 by 9 by 18-in. prisms broken in compression in a Burmah hydraulic press. A few of the comparative strengths obtained were as follows:

Mix	Age, days	Compressive Strength, psi	
		Portland Cement	Roman Cement
Neat	30	2074	746
1:2 sand	52	1244	83
1:3 sand	52	691	

No mention is made of water content of these mixes, nor of their relative consistency.

There are further references to additional tests made at a Mr. Jackson's works in 1851, in which the superiority of portland cement over Roman and other natural cements in compression was again demonstrated. It is interesting to note that the prisms were reduced to 6 by 6 by 12 in. in size, possibly because in the 1848 tests one of the stronger larger specimens wrecked the hydraulic press.

According to Redgrave and Spackman,[2] we have the French to thank for tension testing. The Engineers of Bridges and Embankments made a systematic study of portland cement in the period 1848 to 1850. They used a briquet with a cross-sectional area of 2.25 sq. in. (waiving the use of the metric system, probably in deference to the English, who were at that time the only portland producers). Their average results on neat and 1:2 sand specimens ran as follows:

Age, days	Strength, psi	
	Neat	Sand
2	141	
5	282	141
30	529	282

John Grant of the London Metropolitan Board of Works adopted the French tension test in 1859. The original specimen consisted of two prisms connected by a $1\frac{1}{2}$ by $1\frac{1}{2}$-in. square neck. Later, Grant experimented with nine other forms, on which he published information in 1871. In 1880, he recommended a briquet with a 1-in. square minimum section, with contours at the waist identical with our present specimen.

According to the report of Subcommittee VII on Strength of ASTM Committee C-1 on Cement,[3] submitted in April 1916, criticism of tension testing of cements has been of very long standing. The following is a condensation of the 1916 Strength Subcommittee's report.

Tensile tests of briquets of cement and sand mortar nearly always show a retrogression in strength which begins at ages of 7 days to 6 months. Diagrams illustrating this early retrogression are common in engineering literature. The reader is generally allowed to conclude from statements concerning the relation between tensile and compressive strength that this same relation may be expected to hold in the strength of concrete.

That this retrogression is peculiar to the briquet test and not to the material is well known to all who have studied concrete tests. The curves in Figs. 1 and 2 show the characteristic decline in strength of the tensile test pieces, both neat and 1:3 mortar, and the corresponding increase in strength at all periods for the 2 by 4-in. cylinders. These tests were made in the same laboratory and under the same general conditions.

[Present author's note: The accompanying Fig. 3 shows the relation in strength between 1:3 briquet strengths

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NOTE.—DISCUSSION OF THIS PAPER IS INVITED, either for publication or for the attention of the author. Address all communications to ASTM Headquarters, 1916 Race St., Philadelphia 3, Pa.

* Presented at the Cincinnati Spring Meeting of Committee C-1, February 1, 1955.

[1] A. C. Davis, "One Hundred Years of Portland Cement," Concrete Publications, Ltd., London (1924).

[2] G. R. Redgrave and Chas. Spackman, "Calcareous Cements," Chas. Griffin and Co., London (1924).

[3] "Report of Subcommittee VII on Strength," Data Considered by Committee C-1 in Preparing the Standard Specifications and Tests for Portland Cement, Am. Soc. Testing Mats., Section II, Part VIIA, p. 59. (Issued as separate publication, *ASTM STP No. 4.*)

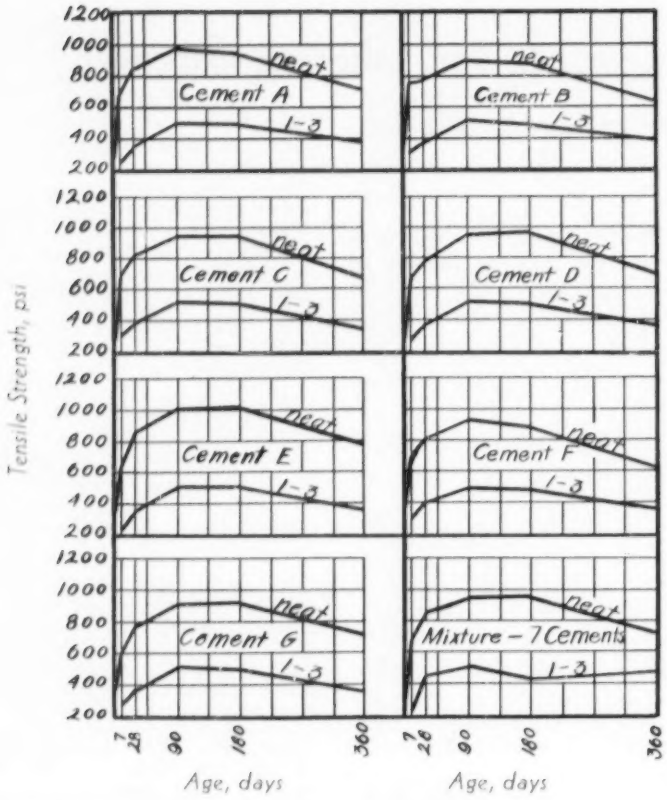

Fig. 1.—Effect of Age on Strength of Cement Briquet Tests. Neat Cement and 1:3 Standard Sand Mortar.

(Report of Subcommittee VII, compiled from *Bulletin No. 331*, U. S. Geological Survey)

and strengths of concrete made with the same group of 46 samples of an early high-early strength cement, produced in 1929–1930.]

While certain modifications have been made in size and contour, the present (1916) briquet is open to all the objections lodged against the original form. As long ago as 1898, Prof. J. B. Johnson pointed out the great inequality in stresses developed in the minimum section of the briquet. As a result of an analytical study, he concluded that the maximum stress in a briquet is equivalent to about 1.54 times the minimum stress.

Mr. E. G. Coker found even greater inequalities. Coker's results were derived from a study of the polarizing effect which results from stressing a briquet made with transparent celluloid. As a result of these tests, he concluded that the highest stress in the minimum section of the briquet is 1.75 times the mean stress.

[Present author's note: Figure 4 shows the distribution of stresses in a briquet according to these two authors. The much higher strengths and therefore rigidities of modern portland cement mortars, as compared with the 1916 products, greatly aggravates these inequalities, beyond what Coker calculated.]

This inequality in stresses results from the briquet shape and method of applying the load. The concentrated loads which are applied by the clips at four points in the section must be transmitted in a very short distance to the entire cross-section. It can readily be seen that anything approaching a uniform distribution of stress over the minimum section is impossible.

This inequality of stresses in a briquet accounts for the retrogression which occurs in the strength of briquets with age. At early ages the material has a low modulus of elasticity. Hence the differences in stress between the outer edge and the middle section are not as great as when the material has a much higher modulus. With a very rigid material, the opportunity for an adjustment in stresses within the specimen is much less than in a material of low rigidity. In older briquets a very high stress is developed at the edges of the section; hence a tearing action is produced which results in rupture at a lower total load than had been withstood at an earlier age when the lower rigidity permitted a more uniform distribution of stress.

That the rigidity of the specimen is largely responsible for retrogression in the strength of briquets is further shown by the fact that high-early strength cements show retrogression at earlier ages than cements which attain strength more slowly, and that the richer the mix, the earlier retrogression begins.

In testing cement in tension, we are in reality subjecting a material of nonuniform and changing stiffness to eccentrically applied loads, which is contrary to sound engineering principles.

The defects of the briquet as a test piece are particularly emphasized in neat cement briquets on account of the high degree of stiffness which is attained at early ages. This no doubt largely accounts for the early retrogression in strength which is always observed in neat briquet tests.

The foregoing discussion of the stresses in a briquet indicates numerous objections to this form of test piece. This Subcommittee is of the opinion that *all briquet tests* should be abandoned as soon as the compression test can be standardized and brought into general use. However, *considerable time will be required before such a complete change in testing methods is feasible.* (Italics by the present author.)

The 1916 Subcommittee on Strength did succeed in eliminating the neat briquet, but the 1:3 sand briquet is still in use. The committee presented a tentative method[4] for compression tests of the standard briquet 1:3 mortar in 2 by 4-in. cylinders. This test was never successful due to three inherent faults. First, the low water-cement ratio of about 0.40, by weight, made the mortar nonplastic and difficult to mold properly. Second, it was difficult to secure a plane top surface, which is essential to good testing. Last, and most important, there were no good hydraulic testing machines available, and screw-type machines frequently had enough side travel of the head to stress the 2 by 4-in. cylinders laterally as well as vertically.

A later C-1 Working Committee on Strength (1932–33) proposed a method of test which eventually became ASTM Method C 109.[5] Their test method met most of the objections to the old cylinder test for standard mortars. The uniform water-cement ratio of 0.53, by weight, was close to that for good con-

[4] Specifications and Tests for Compressive Strength of Portland-Cement Mortars (C 9–16 T), 1917 Book of ASTM Tentative Standards, p. 630.

[5] Method of Test for Compressive Strength of Hydraulic Cement Mortars (C 109–54 T), 1954 Supplement to Book of ASTM Standards, Part 3, p. 16.

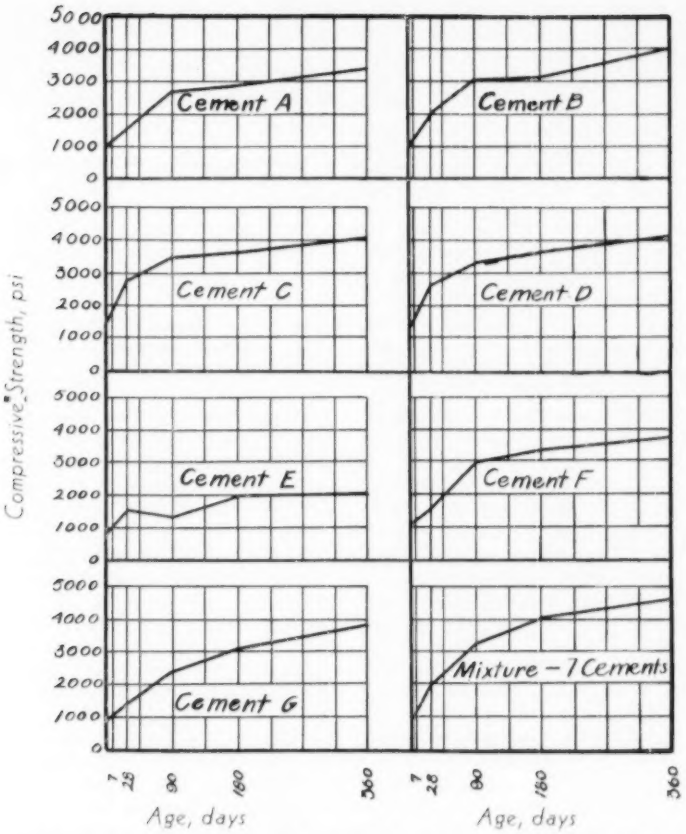

Fig. 2.—Effect of Age on Strength of Cement. Compression Tests of 2-in. Cubes, 1:3 Standard Sand Mortar.

(Report of Subcommittee VII, compiled from *Bulletin No. 331*, U. S. Geological Survey)

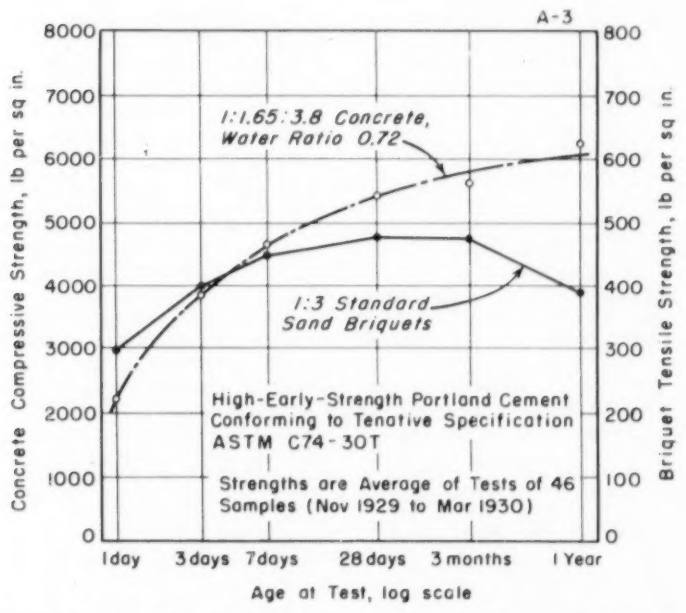
A-3
1:1.65:3.8 Concrete, Water Ratio 0.72
1:3 Standard Sand Briquets
High-Early-Strength Portland Cement Conforming to Tentative Specification ASTM C74-30T
Strengths are Average of Tests of 46 Samples (Nov 1929 to Mar 1930)
Concrete Compressive Strength, lb per sq in.
Briquet Tensile Strength, lb per sq in.
1 day
3 days
7 days
28 days
3 months
1 Year
Age at Test, log scale

Fig. 3.—Comparison of Tensile Strength of 1:3 Standard Sand Briquets and Compressive Strength of 6 by 12-in. Concrete Cylinders.

crete practice, the mix was plastic enough to mold well, and troubles with the end condition of the cylinders were ended by breaking specimens on their molded plane sides. The first proposal of the subcommittee was to limit tests to a hydraulic machine, with loading at the rate of 4000 psi per min. This would eliminate the lateral stresses which were typical of so many screw-type testing machines.

There was an immediate and strenuous objection lodged by screw-type machine manufacturers against such a recommendation by the working committee. The objection was sufficient to convince the majority of the subcommittee that they must admit both types of machines. However, at the insistance of a minority member they put in a note covering "Faulty Cubes." This note read much the same as our present Note 4 in Method C 109[5]: "Improper centering of cubes resulting in oblique fractures or lateral movement of one of the heads of the machine during loading will often cause lower strength results. Cubes so broken shall be considered as "manifestly faulty" (and here the original differs from the present C 109 note) unless their strengths agree within reasonable limits with those of cubes exhibiting a *normal pyramidal fracture*. Such breaks could not be obtained if lateral movement of the head occurred.

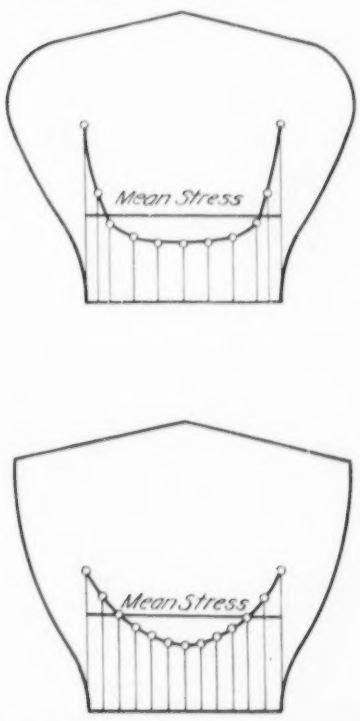

Fig. 4.—Distribution of Stresses in a Briquet. (Report of Subcommittee VII.)

The matter of pyramidal fracture has been overlooked sometime during the past 20 yr—perhaps it is no longer of importance, since hydraulic testing machines are in use for such purposes almost universally.

In tracing this history of strength testing we have seen the evolution of testing technique go full circle: first, the testing of concrete prisms by compression in a hydraulic machine; next the adoption of the tension briquet as an almost universal test specimen for a long period of years, regardless of its faults; the development of a good compression test on mortars; and now finally, the present proposal of the C-1 Sponsoring Committee on Portland Cement to delete the tensile strength requirements in Specifications C 150.[6] Since 39 years have now elapsed since the abandonment of the briquet was first recommended, it now seems high time for a change!

[6] Specifications for Portland Cement (C 150-53), 1953 Supplement to Book of ASTM Standards, Part 3, p. 1..

DISCUSSION

Mr. W. C. Hanna.[1]—The paper is interesting and thought-provoking, but it is not comprehensive enough to warrant any conclusion. Essentially the author has given a limited historical review of the testing of cement for strength and then launched into a condemnation of the tensile strength test and requirements by quoting rather liberally from an old report issued in 1916.

The emphasis and explanation given to the word "inherent" in the introductory paragraph and the comments about rigid controls seem unnecessary since no further attention is really given to the problem of correlating laboratory strength values with those obtained in the field or even between laboratories. The idea of having a test for inherent strength that simulates end use of cement as suggested by Mr. Swayze is good, but in the case of hydraulic cements we question very seriously whether it is possible because of the many factors involved. Engineers and designers would undoubtedly appreciate such a test and so would the producers of cement. However, the first main problem is to find a good reproducible physical test that will check between laboratories as well as within laboratories.

In a recent cooperative test program conducted by the Working Committee on Strength (ASTM Committee C-1 on Cement), under C. E. Wuerpel,[2] some pertinent data were developed on this problem of providing a test that is reproducible. Eight cements, each carefully blended for uniformity, were submitted to eight competent cement testing laboratories for comparative testing in a study of machine mixing *versus* hand mixing of the mortars, to be used in ASTM Method C 109 covering the compression test of 2-in. cubes.[3] It is assumed that precise control of all factors was carefully maintained under good supervision, but still the results for compressive strength at 28 days (or at 7 days for type III) showed that the difference between maximum values and minimum values for any one cement ranged between 20 and 35 per cent of those minimum values with several approaching 50 per cent. (The strength values used were reportedly the average of three specimens in each case.) To suggest that a test method of this type can be of more than general value to interested users is not reasonable.

On a practical basis, let us consider the above data and attempt to project an interpretation to the end use of concrete in the field where just about every condition is likely to vary, any one of which, singly or in combination with others, will drastically affect the strength of the concrete. Cement and aggregate proportions may change with different jobs. The physical and chemical properties of aggregates and the size gradations will not be the same from job to job. The amount of water used and its quality can vary. The mixing and placing of concrete may be very erratic. And then, to top it all, curing may take place at high or low temperatures, with and without adequate moisture. On big jobs, engineers will try to control most of these factors, but there are practical limits. Even strength values of test specimens obtained on the job may be open to question. Inge Lyse pointed out in the 1935 ASTM Report on Significance of Tests of Concrete and Concrete Aggregates[4] that specimens not handled in exactly the "same manner" as the concrete placed in a structure "may often be more misleading than helpful."

The 1916 report referred to by Mr. Swayze brings up the subject of inequality of stresses in briquets under load and the increased rigidity of specimens with age. These are offered as explanations of the strength retrogression that has been observed for some cements when they were subjected to tension testing. However, their claim that retrogression may start at 7 days is not backed up by the data presented in either Fig. 1 or Fig. 3. The 1916 data given in Fig. 1 do not show retrogression until after 90 days and the data in Fig. 3 not until after 28 days. Such data, though, are very interesting and should not be ignored. However, in these cases it is that property of cement shown by retrogression of strength that should be criticized and not the method for determining it. It could be called one of the inherent properties that probably exist to a greater or lesser degree in some cements. The question of whether the retrogression effect is good or bad is not too clear, but there are some indications that it is a property which design engineers should be aware of. It appears to indicate the development of a very rigid mortar, and when observed at an early date by any test, it could mean that the cements are so active that the initial concrete stresses will not be permitted to equalize. The standard tension test offers a good means of checking on this property at an early date.

Actually, long-time data for compression test specimens have shown the same strength retrogression; thus it is not an exclusive property of the tension test (or the shape of the briquet used in tension testing). Data reported by Davis, Hanna, and Brown[5] in 1949, covering a 10-yr test period, show that both compressive and tensile mortar specimens exhibited retrogression when stored in water under standard conditions of curing. At the same time, both types of specimens showed strength increases up to 10 yr

[1] Vice President in Charge of Technical Development, California Portland Cement Co., Colton, Calif.

[2] Cooperative Test Program to Investigate the Effect of Mechanical Mixing on the Compressive and Flexural Strength of Portland Cement Mortars, to be published in the ASTM *Proceedings*.

[3] Tentative Method of Test for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. Cube Specimens), 1954 Supplement to Book of ASTM Standards, Part 3, p. 16.

[4] Inge Lyse, "Compressive Strength of Concrete," Report on Significance of Tests of Concrete and Concrete Aggregates, Am. Soc. Testing Mats. (1935, 1st Ed.; 1943, 2nd Ed.) (Issued as separate publications *ASTM STP Nos. 22* and *22-A*).

[5] R. E. Davis, W. C. Hanna, and E. H. Brown, "Strength, Volume Changes, and Sulfate Resistance of Mortars Containing Portland-Pozzolan Cements," Symposium on Use of Pozzolanic Materials in Mortars and Concretes, Am. Soc. Testing Mats., p. 151 (1949). (Issued as separate publication, *ASTM STP No. 99*.)

when stored in air after the initial 28-day period of standard curing in water. It may be noted that the retrogression of strength of specimens stored in water occurred at the same time for both types of strength tests. Figure 3 of Mr. Swayze's report is worthy of special note in this connection since it indicates that the tension briquets are more sensitive than cubes in compression. It is unfortunate that these compressive tests were not carried forward for a period of years to indicate the time required to show the retrogression suggested in less than a year by the tension test.

Long-time tests that the writer has made in the past indicate that briquets having a dense composition will show up very well. For example, briquets made with 1 part cement, 4 parts standard Ottawa sand, 2 parts rock dust, 1 part fine sand (1 part cement to 7 parts aggregate), and 10 per cent water gave the following average values based on five tests for each period:

Age	Tensile Strength, psi	
	Water Storage	Air Storage After 28 days
7 days	147	...
28 days	242	...
3 months	283	378
6 months	321	356
1 yr	363	414
2 yr	382	506
6 yr	446	430
10 yr	480	447
15 yr	490	482
20 yr	538	491

In another example of work that the writer has done, the briquets were made with 1 part cement, 4 parts standard Ottawa sand, and one part fine rock dust (1 cement to 5 aggregate). Results were as follows:

Age	Tensile Strength, psi	
	Water Storage	Air Storage After 28 days
1 day	116	...
3 days	265	...
7 days	331	...
28 days	411	...
3 months	468	644
6 months	497	664
1 yr	473	597
2 yr	490	645
5 yr	488	920
10 yr	477	1048

These data, showing high tensile strength values on a long-time basis, indicate that the cement and the mix design may have a pronounced effect on this matter of retrogression in strength, and also that unequal stresses may not be the explanation as claimed by Mr. Swayze.

Now as a matter of interest, we should inquire whether another test for inherent strength is available that is as good as the tension test. The author implies that the compressive test is superior, but just how good is it? The cooperative data already discussed strongly point out the problem of reproducibility for that test. Compression specimens start out as plastic masses which with time become rigid the same as the tensile specimens. When subjected to load, complex stresses are developed that are not ideal. The shape and size of compression specimens have a marked effect on strength values. In 1925, H. F. Gonnerman[6] reported data on this important subject which showed that the relationship between the length and diameter of specimens and their overall size affected the strength values observed. The length-diameter ratios within the range of 1.5 to 2.5 were favored, and he therefore concluded that the 6 by 12-in. cylinder then in use was a satisfactory shape for compression testing. In 1945, John Tucker, Jr., presented a somewhat similar study[7] on the relationship of specimen length to compressive strength and generally concurred with Mr. Gonnerman on the preferred ratios. He specifically suggested the range of 1.5 to 2.0. With these references in mind, it may be fair to ask the proponents of compression test methods for an explanation of the "cube"-shaped specimen required in the ASTM Method C 109 which has a ratio of only 1:.

Another point of interest in regard to the standard compression test of cubes is the observation made by E. E. Butterfield in his discussion of Mr. Gonnerman's paper. Mr. Butterfield reported that his studies have shown that the compressive strength of specimens will vary depending on the direction of load application, being higher when applied in the same direction as the original mortar compaction and being less when applied at right angles. The ASTM standard cube in comparison is tested at right angles, and the reason for this questionable technique is probably based on the essential need of applying a load to a perfectly plane surface such as that developed in a good cube mold. Mr. Gonnerman in another paper published in 1925[8] emphasized the importance of plane surfaces. He reported that a convexity of only 0.01 in. decreased the strength of concrete specimens about 35 per cent. Considering the variations in recent test results obtained by this method, it may be that the surfaces of the cube-molds in use are not so true a plane as expected or required.

The references to the above articles, which are concerned mainly with the compression test, have been brought up in an attempt to show the reader of Mr. Swayze's paper that while some limitations exist for the tension test, so too are there many limitations to the compression test. From a practical standpoint, the criterion for either test should probably be based on usefulness and on reproducibility. The report[9] by the Working Committee on Strength in 1949 under G. L. Lindsay provided cooperative data that showed the tension test to be somewhat more reproducible than the compression test. This was not an outstanding difference, but considered in connection with the fact that cements which pass the simple and inexpensive tension test have never failed to pass the compression test, it is an important point. From a further practical standpoint, it is well to remember that the tension test has been standard and free of trouble for many years. Thus, good comparative data are available for long-time studies. While design engineers may be interested in the inherent strength of cement, producers of cement are directly concerned with that property on an everyday basis in the quality control of their product. The tension test has admirably served this purpose over a period of years, during which time cement production has increased many fold. In closing, I would recommend that we continue the present methods of tests and specifications which allow the use of either method.

MR. M. A. SWAYZE (*author's closure*). Mr. Hanna's comments are of much interest since he has been one of the principal proponents of the briquet test on Committee C-1 for many years. His present arguments for the briquet and against compression testing are the same as those previously advanced many times: the tension test has been standard and free from trouble for many years; it is more reproducible

[6] H. F. Gonnerman, "Effect of Size and Shape of Test Specimens on Compressive Strength of Concrete," *Proceedings*, Am. Soc. Testing Mats., Vol. 25, Part II, p. 237 (1925).

[7] J. Tucker, Jr., "Effect of Length on the Strength of Compression Test Specimens," *Proceedings*, Am. Soc. Testing Mats., Vol. 45, p. 976 (1945).

[8] H. F. Gonnerman, "Effect of End Condition of Cylinder on Compressive Strength of Concrete," *Bulletin 14*, Lewis Inst., April, 1925.

[9] Appendix I, Report of Committee C-1 on Cement, *Proceedings*, Am. Soc. Testing Mats., Vol. 49, p. 263 (1949).

in comparative tests between laboratories than the cube compression test; it is simple and inexpensive to make. I fail to find anywhere in his discussion either claim or intimation that the briquet will better predict the flexural or compressive strength of the cement in controlled concrete.

As I pointed out early in my paper, an acceptable test for strength must not only be reproducible in different laboratories, it must also indicate how the cement will perform in the field in controlled concrete mixes. It is granted that briquets are cheaper and easier to make and that they can be depended upon to maintain a gratifying uniformity from day to day when cement production at plants is tested for strength by this method. The cause for this is simple. A cement with lower inherent strength has a lower modulus of elasticity and consequently is less subject to strains in breaking the briquets. The indicated strength is therefore closer to the true tensile strength than for high-strength specimens with a high modulus which lose much more of their true strength value. Cube tests show no such leveling of strength values unless strict process control is exercised.

The examples of wide variations in compressive strength values in the 1954 report of the C-1 Working Committee on Strength referred to by Mr. Hanna cease to be so alarming when the data are analyzed. Nine laboratories participated in these tests, including five cement producers, two state highway departments, and two Federal bureaus. Eight laboratories reported data. One laboratory made only single tests of three cubes each. The rest made three rounds of three specimens for each age of test. Mortars were mixed both by hand and by machine.

For each type of mixing, the high values were all confined to two laboratories. Even with these high values included, the coefficients of variation between laboratories were not so bad as Mr. Hanna's discussion would indicate. These results are reproduced below:

COEFFICIENTS OF VARIATION, EIGHT LABORATORIES.

Cement	Type	Hand Mixed Cubes			Machine Mixed Cubes		
		3 Days	7 Days	28 Days	3 Days	7 Days	28 Days
20	I	8.9	8.3	11.3	7.3	6.6	9.1
26	I	11.2	6.6	7.0	10.8	6.5	6.1
27	I	6.7	8.1	7.6	4.6	4.8	6.2
22	IA	9.3	8.2	7.4	6.3	6.8	6.8
24	IA	7.6	6.7	7.1	7.1	8.9	6.3
21	II	13.8	9.5	6.8	12.7	9.5	4.9
		1 Day	3 Days	7 Days	1 Day	3 Days	7 Days
23	III	9.1	6.0	6.5	10.2	5.3	5.6
25	III	7.3	5.6	6.0	9.0	5.1	4.8

None of the laboratories reported curing temperatures or tensile strengths, so it is not known whether the higher variation coefficients shown by cements 20, 26, and 21 are due to poor blending of these samples or temperature differences, or whether tensile strengths would have shown any better concordance. No concrete tests were made in this series.

In the earlier 1949 report of the Working Committee on Strength referred to by Mr. Hanna, 15 laboratories cooperated in the testing of four cements, making briquets, 2-in. cubes, and 2-in. mortar prisms similar to those now widely used in Europe, and also modulus of rupture and compressive tests on 6-in. concrete beams. The concrete tests were made with local sands and coarse aggregates with uniform cement contents and slumps, and consequently the water-cement ratios and strengths were variable.

The committee not only figured percentages of mean variation between laboratories on the briquets, cubes, and mortar prisms but also calculated correlation coefficients of these tests with the averages for modulus of rupture and compressive strengths of the concretes. The mean variations were as follows:

Cement	3 Days	7 Days	28 Days
	Briquets		
A	4.2	3.6	4.0
B	6.0	5.1	4.0
C	4.5	5.4	4.9
D	6.2	5.8	6.5
Average	5.2	5.0	4.8
	2-in. Mortar Cubes		
A	6.8	5.3	6.8
B	9.4	7.4	5.6
C	7.4	6.0	6.6
D	9.5	4.3	3.9
Average	8.3	5.8	5.7
	2-in. Mortar Beams		
A	8.2	6.1	6.9
B	7.5	6.7	5.2
C	9.3	6.1	6.2
D	7.5	6.8	6.9
Average	8.1	6.4	6.3

Two of the laboratories had no experience in making the cubes, and the mortar beam test was new to all of them, facts which may have contributed to the variations found.

The correlation coefficients of the three mortar tests with concrete strengths were as given below:

	Method C 190 Briquets	Method C 109 Cubes	Mortar Prisms
Correlation coefficients for modulus of rupture of concrete	0.919	0.949	0.903
Coefficient for compressive strength of concrete	0.903	0.938	0.886

The above results not only show the cube test to be a considerably better index of concrete strength than the briquet, they also refute the argument that the briquet test should be retained because everyone knows how to make it. The fact is that the mortar-beam test which was new to all laboratories was practically as good an index as the briquet.

In a cooperative series of tests by four laboratories conducted in 1934–1935 on 34 type III cements by the Committee C-1 High-Early-Strength Sponsoring Committee, briquets, mortar cubes, and 6 by 12-in. concrete cylinders were made and compared for strengths. At that time there were no compressive strength limits in the cement specification, although Method C 109 existed in tentative form.

All concretes were made with local aggregates, using a uniform water-cement ratio of 53 per cent by weight. Curing temperatures were variable in one laboratory, ranging from 70 to 65 F or less at night. In the other three, average temperatures ranged from 68 to 71 F. All laboratories made two rounds of three specimens each for each test age.

Percentages of mean variation between laboratories on the 34 cements averaged as follows:

	1 Day	3 Days	7 Days	28 Days
Briquets	5.0	5.4	4.5	4.5
2-in. cubes	11.6	8.2	7.2	6.7
Concrete cylinders	11.5	4.9	4.0	2.8

The high mean variations for the cube tests were largely due to use by one laboratory of graded Ottawa sand which did not meet fineness requirements and gave consistently high strengths. The other three laboratories showed much closer agreement. The uniformity of

concrete strengths in all four laboratories after the 1-day age exceeded the uniformity of the briquets.

Using the averages of strengths from all laboratories on each cement as the basis of comparison, the variations in strength of the 34 cements were also calculated. The percentage mean variation between brands, as indicated by the three types of test, ran as follows:

	1 Day	3 Days	7 Days	28 Days
Briquets	6 4	4 2	4 6	4 2
Cubes	11 1	10 6	10 3	8 7
Concrete cylinders	11 5	8 7	7 2	7 0

Considering the fact that many of the type III brands tested had been on the market for no more than 2 to 3 years, the uniformity among them as indicated by briquet tests is preposterous. As pointed out at the beginning of this closure, the reason for this leveling of high- and low-strength mortars lies in the briquet shape and the varying effect of modulus of elasticity on the results.

I shall not discuss in detail the matter of retrogression, to which Mr. Hanna has devoted much space. Suffice it to say that normal cements do not show this property except in the briquet test. The 46 type III cement samples covered by Fig. 3 of the paper continued to gain in compressive strength past the 1-year age up to 10 years, which was the last age of test.

One correction must be made to Mr. Hanna's comment, namely that the failure of the letter ballot of Committee C-1 to delete the tensile-strength requirements in Method C 150 "is sufficient proof that the tension test is still considered to be the most satisfactory and useful method by the majority of users." The letter ballot of Committee C-1 on this deletion was 48 favorable, 26 negative, 8 not voting, and 7 ballots not returned. By no means all of the negative votes were from users. It is, therefore, quite incorrect to state that this 29 per cent of the voting membership of Committee C-1 constitutes a "majority."

Elsewhere the tension test has been deleted from most cement specifications. In western Europe nearly all countries are using a flexure test on mortar beams, with compression tests made on the broken ends. In our own country, tension testing has been out of Federal specifications for several years. There have never been tensile limits in Method C 175 covering air-entraining cements. It is high time they were deleted from Method C 150 as well. It does not indicate to the user the variations he finds in well controlled concrete due to variability in the inherent strengths of cement. The compression test will give him that information.

Suggestions on the Planning of Fog Rooms for Curing Concrete Test Specimens

By C. A. Carpenter

Many curing rooms fail to comply with the basic requirement for surface wetness of concrete test specimens and some fail to maintain the temperature control required by accepted standards. The author describes means for meeting these objectives.

DISCUSSIONS and correspondence concerning desirable features of fog rooms for curing concrete test specimens, in connection with laboratory research and quality control of materials, have pointed up the need for a summary of present thinking as to what constitutes a satisfactory facility.

The Society has set up standard requirements for the preparation and curing of concrete test specimens in the laboratory under ASTM Method C 192.[1] This test method requires that specimens be stored in a moist condition at a temperature within the range of 65 to 75 F until the time of test and that they shall not be exposed to a stream of running water. A moist condition is defined as that in which free water is maintained on the surfaces of the specimens at all times. No minimum requirement for relative humidity is included. Storage in a saturated solution of lime in water may be used to satisfy the surface wetness requirement. Except for providing special temperature limits for a 24-hr field storage period before removal of test specimens from the molds, the requirements for curing specimens made in the field, ASTM Method C 31,[2] are the same.

A practical means of providing water in the curing room atmosphere sufficient to maintain the surface-wet condition without exposure to running water is to maintain a dense fog of minute or atomized droplets of water in the room at all times and to so regulate the quantity and quality of the fog as to prevent unnecessary run-off of water from the surfaces of the specimens.

In practice there is a tendency to maintain somewhat narrower temperature limits than those specified in Method C 192, as well as to devote considerable attention to means of maintaining a high humidity. A temperature requirement of 73.4 ± 2 F has been suggested to replace the 65 to 75 F range for curing compression and flexure specimens and is included in ASTM Method C 234[3] concerning concrete bond on reinforcing steel. The Centi-

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[1] Method of Making and Curing Concrete Compression and Flexure Test Specimens in the Laboratory (C 192-54), 1954 Supplement to Book of ASTM Standards, Part 3, p. 259.

[2] Method of Making and Curing Concrete Compression and Flexure Test Specimens in the Field (C 31-49), 1952 Book of ASTM Standards, Part 3, p. 1042.

[3] Method of Test for Comparing Concretes on the Basis of the Bond Developed with Reinforcing Steel (C 234-54), 1952 Book of ASTM Standards, Part 3, p. 1030.

grade equivalents, 23 ± 1.1 C, were incorporated in Federal Standard No. 1, dated Dec. 15, 1948. The limits required for moist rooms and curing cabinets for cement mortar specimens, according to ASTM Methods C 109[4] and C 190,[5] are 73.4 ± 3 F.

A method that has been used to some extent for judging the quality of the fog, with respect to its effectiveness in maintaining the necessary moisture conditions, is to shut off the fog sprays and then observe whether a definite fog persists in the room for several minutes thereafter. Some of the following suggestions on the design of fog rooms, especially those regarding ways of preventing abrupt changes in temperature and humidity, are made in recognition of an apparent desire for closer control than that required in ASTM Method C 192.

A considerable amount of information has been obtained on general requirements for fog rooms and on suitable construction principles, materials, and special equipment. Some of this information has resulted from experience in the laboratories of the Bureau of Public Roads and some from inquiries directed to other agencies.[6] It is presented here for the possible assistance of materials engineers and others who may have the problem of providing this type of laboratory facility.

The intent is to suggest materials and construction features that will provide creditable laboratory facilities of a permanent nature. As indicated above, the specific conditions for curing concrete compression and flexure specimens that are to be met under ASTM specifications are quite simple. Actually, just two things are required: (1) temperature control; and (2) provision for maintaining surface wetness without contact with running water. Obviously if the laboratory installation is so designed and operated as to insure compliance with current standard curing requirements, no valid technical criticism can be made of the facilities regardless of how simple or inexpensive they may be. The impression of reliability and progressiveness created by well-designed laboratory facilities that are well kept and efficiently operated is, however, an important consideration. No attempt has been made to suggest what might properly be considered minimum building and equipment for bare compliance with technical requirements.

Location and Construction

The fog room should be an inside room separated or adequately insulated from exterior walls. A location in basement or even sub-basement space is highly desirable. The main consideration is that temperature and humidity fluctuation should be reduced to a minimum. For convenience of operation, preference has been expressed for a relatively long, narrow room with a door in each end wall to facilitate orderly arrangement and classification of test specimens.

Since use of the room involves only storage of specimens and not human occupancy, no windows should be provided and access should be from an interior room or hallway. Direct access from outdoors should be avoided if at all possible. If this cannot be avoided then a small vestibule or air-lock entrance should be provided to prevent sudden temperature changes and corresponding variations in relative humidity.

The interior finish on ceiling, walls, and floor should be durable and resistant to moisture. A concrete ceiling slab is satisfactory; and smooth, well-finished concrete, glazed brick, or glazed clay wall building units are satisfactory for the interior wall finish. A smooth, dense surface, especially for the walls, is highly desirable to facilitate frequent cleaning. Hosing down is the common practice. The ceiling and walls generally will require insulation to insure against excessive heat transfer unless climatic conditions and room location are so favorable as to justify its omission. Where insulation is used, it should be protected against waterlogging by interposing a vapor barrier between the insulating material and the room atmosphere. The floor may or may not require insulation and vapor seal depending on location.

Ceiling—Special Treatment

A method of construction that will fulfill the technical requirements and one that will provide a high degree of permanence is a structural concrete ceiling slab covered on top first with a suitable vapor barrier, next with block insulation, and last with sufficient concrete fill to protect the insulation and to provide, if required, a floor for space above.

Walls—Special Treatment

A double masonry wall is a convenient means of fulfilling the technical requirements. The backup wall may be of concrete, cement block, clay wall building units, or other suitable construction. Inside this, either free standing or suspended, is placed the insulating material. The vapor barrier is placed next and finally the interior finish of concrete or building units such as brick or glazed clay wall units. Metal ties may be used between the inner and outer masonry of the double walls, but if they are used, great care must be exercised to seal all openings made in the vapor barrier to accommodate them.

Vapor barriers for walls and ceiling may be formed with such materials as copper or aluminum foil or, as recently recommended, some of the plastic films (**2**).[7,8] While their principal purpose is to prevent waterlogging of the insulating material, they also tend to protect adjoining space from dampness.

Insulating Material

Information has been obtained on a considerable number of suitable insulating materials. This information is presented in Table I. It is suggested that, if insulation is required, selection of the type to be used should be made in collaboration with the architect so that type of wall, interior finish, vapor barrier, and insulating material will be properly integrated. The ideal insulation requirement would be such as to permit maintenance of the interior room surfaces at a temperature above the dew point, regardless of climatic condi-

TABLE I.—CHARACTERISTICS OF INSULATING MATERIAL.

Material	Weight, lb per cu ft	*K* Factor[a]	Remarks
Cork board, asphalt dipped	7.5	0.27	Strong, not fully vapor proof
Foam glass block	9	0.41	Strong, vapor proof
Cellular rubber board	4.5	0.23–0.25	Strong, vapor proof
Foamed plastic	0.8	0.23–0.30	Highly vapor resistant
Fiber glass, asphalt enclosed	6	0.25	Strong, not fully vapor proof
Fiber glass, asphalt enclosed	9	0.25	Strong, not fully vapor proof

[a] Heat conductivity in Btu per hr per sq ft per in. of thickness per deg Fahr at about room temperature.

[4] Tentative Method of Test for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. Cube Specimens) (C 109-54 T), 1954 Supplement to Book of ASTM Standards, Part 3, p. 16.

[5] Method of Test for Tensile Strength of Hydraulic Cement Mortars (C 190-49), 1952 Book of ASTM Standards, Part 3, p. 167.

[6] Much of the information based on present installations has been obtained through the courtesy of D. E. Parsons, Chief Building Technology Division, National Bureau of Standards, Henry E. Robinson of his staff, and John R. Dwyer, Head of the Cement Reference Laboratory. E. W. Goodwin, Chief, Mechanical and Electrical Engineering, Public Buildings Services, and C. H. Hosmer of his staff furnished information on low-gradient cooling coils and temperature control.

[7] Polyethylene film 0.004 in. thick, as manufactured by the Visking Corp., Terre Haute, Ind., has been recommended as a suitable plastic vapor barrier. Aluminum foil must be thoroughly coated with waterproofing material such as bituminous varnish to prevent corrosion by free lime in the masonry wall.

[8] The boldface numbers in parentheses refer to the list of references appended to this paper.

tions, to prevent loss of moisture from the air in the room by condensation on or behind these surfaces.

Nonskid Floor and Other Safety Features

The floor of the fog room should be of good quality concrete with a rough nonskid finish. Provision against a slippery floor is very important as a means of preventing injury to laboratory personnel when placing or removing test specimens. Floor drains should be provided, and the floor should be sloped toward the drains sufficiently to permit runoff of the free water. A sand trap with readily removable hopper is an essential part of each floor drain to protect the domestic sewer from being clogged.

As a further safeguard to personnel, the entrance doors should have glass sight panels and should be equipped with latches that can be operated from both inside and outside. Doors should open outward. Insulated, metal-clad doors with interior insulation should be used. The metal sheathing should be of a nonrusting material sealed with solder or by welding at all joints. The doors should be gasketed, and high-grade, nonrusting hinges and latches should be specified.

Lighting

Sufficient lighting should be provided to produce an average illumination of the order of 15 to 20 foot-candles when all lights are turned on. However, sufficient light circuits should be provided to permit use of only part of the lights when maximum illumination is not needed in order to prevent unnecessary heat gain. All wiring and fixtures should be vapor proof. All light switches should be outside the room near the entrance door, and the lighting circuits should be wired through small signal or indicating lamps installed near the switches where they will be visible to anyone passing the entrance. Lights should be operated only when there is someone in the curing room. No switches should be installed inside the room for any purpose.

Only specially trained and equipped personnel should be allowed to change light bulbs or operate any electrical equipment in the fog room because of the danger of electrocution resulting from touching electrical fixtures when standing on a wet floor. The use of rubber gloves should be a requirement rigidly enforced. Extension cords should not be permitted in the room for any purpose.

Ventilation

Since occupancy should be almost negligible and the introduction of any appreciable amount of outside air would interfere seriously with maintenance of high humidity, no provision should be made for ventilation. However, this makes it absolutely necessary to avoid storing or using chemicals or perishable, volatile, or toxic materials of any kind in the room. No gas lines should be installed, and if any are present, they should be removed or sealed off in such a way that they cannot be put in service while the space is in use as a curing room.

Fog Equipment

Types of atomizing or fog generating equipment are: spinning disk, steam or air injection, and fog-spray nozzles.

The most practical and easily operated of these is the fog-spray nozzle.[9] A manifold should be used having a number of spray heads of low individual capacity suitably distributed near the ceiling. Each spray head should be individually valved to permit flexibility in operation. A main line valve should be provided near one of the entrance doors so that the spray heads may be turned off conveniently in one operation when it is necessary to enter the room.

In general, fog-spray heads do not operate satisfactorily if the water is not clean and if the pressure varies materially. In most situations it would be highly desirable to deliver the water from the primary supply to a settling tank and to provide all brass or copper piping from the settling tank to the spray heads. If additional protection against clogging of the nozzles is deemed necessary, a filter might well be installed in the delivery line. A small pump in this line, capable of delivering the required amount of water to the spray heads at a closely controlled pressure, would be desirable. Not all water-pressure spray heads can be considered satisfactory since some of them produce a mixture of fog and fairly large droplets or even small jets of free water. Proposed fog-spray heads should be service tested before they are permanently installed.

Air injection spray heads[10] produce a highly satisfactory fog, as demonstrated in the installation of the National Sand and Gravel Assn., College Park, Md. At this installation, the size of the nozzle used is rated at 10 lb of water per hr. It requires 10 cu ft of free air per lb of water, with the air delivered at 30-psi gage pressure. Four nozzles are used in a room approximately 9 by 14 ft with a 9-ft ceiling. The air injection spray head has one disadvantage in that it requires a dependable source of compressed air. This complicates the installation, increases its cost, and adds a unit of equipment that is subject to failure to the same extent as most mechanical equipment.

It is good humidifying practice to introduce the water fog at a temperature slightly higher than that desired in the room and then to cool the saturated air to the desired temperature by fanning it against low-gradient cooling coils distributed around the room against the walls. If the heat transfer surface at the cooling coils is amply large and the temperature differential between the coils and the controlled air temperature correspondingly low, for example 2 F, this type of system will contribute to the maintenance of high humidity. An excessive temperature differential between the cooling coils and the air will cause excessive condensation on the coils and a tendency to lower the humidity. Introduction of the water fog at a low temperature will also tend to reduce humidity.

Heating

Proper location and insulation of the curing room in a heated building should avoid the need of special heating facilities, particularly considering the possibility, or even desirability, of making up for heat deficiency by raising the temperature of the spray water. A simple and highly practical way of doing this, as well as providing the sedimentation chamber suggested in a preceding paragraph, has been worked out in the laboratory of the National Crushed Stone Assn., Washington, D. C., where a thermostatically controlled domestic water heater fulfills both functions. If, because of extremely unfavorable climatic conditions or other limitations, it should be necessary to supply heat not otherwise available, it is recommended that auxiliary warm water pipe coils for heating be installed, rather than providing for any type of air heating. Sufficient coil area should be provided in this case to permit operation at a low differential since extremes of either heat or cold in the coils will destroy the uniformity of temperature and humidity conditions that are essential to consistent test results. No attempt will be made here to suggest actual heating coil areas since local conditions will govern and may be extremely variable. The problem would

[9] A spray head similar to that manufactured by the Spray Engineering Co., 114 Central St., Somerville, Mass., and sold under the designation J 140 D is satisfactory if clean water free of grit or scale can be delivered to it. This head delivers approximately 2.2 gal of water per hr at 40-psi line pressure.

[10] Illustrative of this type is the unit manufactured by the Parks-Cramer Co., Fitchburg, Mass., and Charlotte, N. C. The one sold under the designation, Type TNS No. N 10A13, is rated at 10 lb of water per hr.

be one for a competent heating consultant, familiar with local conditions.

Cooling

It has been found practical in at least one instance to provide for both cooling and heating by regulating the temperature of the spray water. However, it is known that the introduction of sufficient cold water to offset high heat gain, as in very hot climates or poorly insulated space, will tend to reduce the humidity. In the case cited, that of the Connecticut State Highway laboratory, the temperature is maintained between 68 and 73 F by mixing hot and cold water for the sprays in an automatic water tempering valve.[11]

For locations requiring dissipation of a considerable quantity of heat during part or all of the year, especially where cold water is not naturally available, provision for refrigeration and cooling coils would appear to be necessary.

In order to assure successful operation of the cooling coils at a low differential, it is essential that there be very little heat gain through the walls. Any conditions that might tend to cause such a heat gain should be offset so far as practicable in the design of the insulation.

Coils

Extended-surface brass or copper pipe coils are desirable from the standpoint of efficiency, although the extended-surface coils are somewhat more trouble to keep clean than plain pipe. The coils should be divided by manifolding into enough separate circuits so that the refrigerant will be distributed uniformly to all parts of the coils without producing hot or cold spots. The coil banks should be placed as high on the walls as possible to facilitate cleaning both the exposed wall surfaces and the surfaces behind the coils by hosing.

Refrigeration

The most economical way to obtain such refrigerating equipment as might be required is believed to be the purchase of commercial refrigerating units of suitable size and capacity on the advice of qualified factory representatives or air-conditioning consultants familiar with the conditions to be met. Consideration should be given to the possibility of interruption of service because of mechanical failure, and equipment should, if possible, be provided in multiple to ensure: (1) stand-by service; and (2) reserve capacity to take care of unusual loads or heat gain.

[11] The Powers Regulator manufactured by the Powers Regulator Co., Chicago, Ill., is used.

Temperature Control

Operation of the refrigeration units should be by thermostat. The thermostat and all wiring should be placed outside the curing room with a long capillary and remote bulb extending into the room.

Air Circulation

Uniformity, both of temperature and water content of the air throughout the space, is considered essential to proper functioning of the curing room and also to satisfactory control. To provide for this uniformity, it is necessary to have considerable air movement in the room. Several suggestions have been made for providing this, some involving quite elaborate ventilating arrangements with provision for cycling the air through special air-conditioning equipment. It is believed that an arrangement involving small over-all cost for installation and maintenance may properly be selected because of the absence of human occupancy. One suggestion is that one or more large ceiling-mounted fans be used. This would permit placing the motors or drives above the ceiling level with the shafts extending downward into the fog room through bushed sleeves, thus eliminating trouble with motors operating in the wet atmosphere of the fog room.

Racks for Storage of Specimens

In utilizing the curing room it is essential for all specimens to be so placed that water droplets can reach all surfaces. This means that there must be some space completely surrounding each specimen. Mechanical agitation of the air and a sufficient density of water fog can be expected to produce surface wetness in the specimens if the spacing requirements are met. Actually the requirements are met by placing the specimens on the floor since gravity and capillarity operate to wet the face resting on the floor. Specimen racks, if used, should not be made of wood because this promotes the growth of algae both on the racks and on the floor, thus causing a dangerously slippery condition. Therefore it is urged that any specimen racks installed in the fog room be constructed entirely of metal and, furthermore, that a non-rusting metal be used. It is believed that, generally, the high cost of racks built of rolled or extruded aluminum or of stainless steel would be fully justified over a period of years because of the saving in maintenance costs. A considerably less expensive type of rack, which is said to have a good record of serviceability, is one prefabricated of plain steel shapes and, after fabrication, coated with zinc by hot dipping.

The racks should be so designed that either cylindrical compression specimens or flexural test beams can be laid horizontally on the racks, preferably crosswise with two-point support and without contact with adjacent specimens. Crowding of racks should be avoided. Preferable arrangement of racks would be along the walls, with adequate space between the walls and the racks to permit fog circulation.

Conclusion

It is recognized that adequate standardization of the curing method is essential if dependable results in testing concrete are to be obtained. Convincing evidence of this is to be found in a report by D. L. Bloem (3) who has investigated the matter very thoroughly and competently. Therefore, it is highly important to provide carefully designed and controlled facilities for curing the test specimens. The suggestions that have been made are not intended to constitute a specification in any sense of the word. Some of the suggestions have general application, and others would apply primarily in very hot or very cold climates. In general, the suggested requirements are intended to provide for a considerably greater degree of permanence, refinement of control, and convenience than would be necessary in designing the minimum facilities that would barely meet ASTM standards.

References

(1) V. L. Glover, "Curing Rooms and Cold Tests for Better Concrete," Illinois Division of Highways, *Engineering News-Record*, Vol. 117, No. 26, December 24, 1936, pp. 893–896. Design and description of curing rooms discussed.

(2) "Plastic Film Is Permanent Moisture Barrier," *Construction Methods and Equipment*, Vol. 37, No. 3, March, 1955, p. 87.

(3) D. L. Bloem, "Effect of Curing Condition on Compressive Strength of Concrete Test Specimens," *Circular No. 59*, National Sand and Gravel Assn.; see also *Publication No. 53*, National Ready Mixed Concrete Assn.

(4) Roderick B. Young, "The Field Testing of Concrete," *Proceedings*, Am. Soc. Testing Mats., Vol. 27, Part II, p. 390 (1927).

(5) E. L. Conwell and J. L. Miner, Discussion of paper by H. S. Mattimore, *Proceedings*, Am. Soc. Testing Mats., Vol. 25, Part II, p. 198 (1925).

(6) "Curing Specimens" and "Strength Tests," Manual of Concrete Inspection, Am. Concrete Inst., pp. 146, 150–151 (1955).

A Method for the Determination of the Cement Content of Plastic Concrete

By W. G. Hime and R. A. Willis

THE use of heavy liquid media for separating suspended solids of varying density has become widespread among mineral industries. R. A. Willis, co-author of this paper, apparently was the first to suggest that heavy media separation might be used for the removal and measurement of cement in fresh concrete. The Research and Development Division of the Portland Cement Assn. has experimented with the idea sufficiently to show that such use of heavy media separation is valid in principle and has considerable practical promise. At the present stage of these studies, it seems evident that progress toward perfecting this method of cement determination requires that numerous interested organizations and agencies act collaboratively in carrying out field trials under many different circumstances and job conditions. The amassing and analyzing of such experience would seem to be best done under the guidance of such a body as a properly chosen committee of the American Society for Testing Materials. With this in mind, all of the data from the Portland Cement Assn. laboratory investigation, together with the results of some limited field trials which the Association's Research and Development Division has carried out, has been turned over to Subcommittee III-c on Methods of Testing Fresh Concrete of ASTM Committee C-9 on Concrete and Concrete Aggregates for such further action as that committee deems suitable.

Since cement content is one of the basic indices of quality concrete, an accurate and rapid procedure for determining cement content of plastic concrete would appear to be a useful tool. A test of this sort would provide pertinent information at the time of placement, well in advance of the results of another index of quality—the conventional strength tests. The test might be satisfactorily performed by university, commercial or state and other public testing laboratories.

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[1] The boldface numbers in parentheses refer to the list of references appended to this paper.

This method utilizes the principle of heavy media separation which, according to the literature, has not hitherto been applied to plastic concrete.

This report describes the work that has been done toward the development of such a test, utilizing the principle of heavy media separation. According to a literature survey (a summary of which follows), this is the first time the principle has been applied to the separation of the component parts of plastic concrete, although a possible procedure has been suggested for the use of heavy media in experimental work with cement mortars. The heavy media used is a liquid mixture whose specific gravity may be adjusted to a value intermediate between that of cement and fine aggregate, thereby permitting the cement to sink and the aggregate to float. A centrifuge is used to accelerate the separation. By means of appropriate calibration curves, cement content may be estimated.

Survey of the Literature

In reviewing the literature dealing with analysis of the constituents of fresh concrete, the chemical methods not readily adaptable to field use were not included. A large proportion of the publications is either directly concerned with the Dunagan (1-9)[1] method of analysis or consists of proposed methods similar in many respects to that of Dunagan. The Dunagan process involves weighing a 3000 to 4000-g sample of the fresh concrete in air and water. Those portions of the sample that remain on Nos. 4 and 100 sieves after wet sievings are also weighed in water. The weight of the material passing the No. 100 sieve is found by difference and is taken to be cement. The specific gravities of the cement, sand, and gravel are needed to calculate the original proportions of the concrete constituents.

Methods requiring the measurement of specific gravity have been criticized because such determinations are difficult to perform accurately (4,8,10). Methods which assume that the weight of all material passing a certain sieve is cement may be inaccurate because some sand passes the sieve. The grinding action of mixing operations is said to increase the amount of fine sand, and large errors may result (6,11).

Others have modified the Dunagan apparatus to shorten the test (12) (the wet-sieving operation of the Dunagan procedure is difficult) or to permit the use of larger samples (13,14). Although an accuracy within about 1 per cent of the cement content has been claimed under some circumstances, specific confirmatory data are somewhat limited.

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ROBERT A. WILLIS has been associated with the St. Louis District Office of the Portland Cement Assn. since 1926. His interest in factors affecting quality concrete and construction led to development of the cement determination test.

TABLE I.—EXPERIMENTAL DATA.

Data for the Experiments, Using the Final Procedures, on Types I and III Cements. For Each Batch, Two 25-g Samples Were Used, One in Each Centrifuge Tube.

Aggregate Used	Fineness Modulus	Batch	Equivalent Volume of Cement Layer, ml							
			3 sacks per cu yd		4 sacks per cu yd		5½ sacks per cu yd		7 sacks per cu yd	
			Tube No. 1	Tube No. 2	Tube No. 1	Tube No. 2	Tube No. 1	Tube No. 2	Tube No. 1	Tube No. 2
Type I Cement										
Meramec River Sand, St. Louis, Mo. (lot No. 18899)	2.29	No. 1	107	107	137	145	194	201	248	253
		No. 2	112	112	154	161	196	201	263	273
Hoot Pit Sand, Texarkana, Tex. (lot No. 18556)	2.52	No. 1	107	111	149	156	199	199	248	255
		No. 2	113	115	148	154	202	202	257	257
Mississippi River Sand, St. Louis, Mo. (lot No. 18897)	2.59	No. 1	105	105	144	149	200	207	243	250
		No. 2	106	110	152	152	205	205	253	253
Roquemore Sand, Montgomery, Ala. (lot No. 18818)	2.75	No. 1	113	116	148	148	199	204	253	253
		No. 2	111	115	156	161	206	206	253	253
Seaboard Sand, Port Jefferson, N. Y. (lot No. 18540)	2.77	No. 1	111	111	146	150	198	209	243	250
		No. 2	113	120	146	151	201	201	248	248
Elgin Sand, Elgin, Ill.	2.96	No. 1	107	115	150	155	204	216	265	265
		No. 2	121	130	154	159	220	220	267	274
Averages for type I			112		151		204		255	
Type III Cement										
Meramec River Sand	2.29	No. 1	128	128	172	180	244	253	279	279
Hoot Pit Sand	2.52	No. 1	121	121	163	163	224	217	294	294
Mississippi River Sand	2.59	No. 1	131	135	168	168	246	246	264	270
Roquemore Sand	2.75	No. 1	130	130	166	167	242	242	284	290
Seaboard Sand	2.77	No. 1	134	137	169	164	240	240	278	278
Elgin Sand	2.96	No. 1	105	114	176	176	250	256	291	298
Averages for type III			126		169		242		283	

Whereas the Dunagan method determines the displacement of the constituents from their buoyancy, there are two other methods that are similar except that they determine displacement by the volume of water displaced (**10**) or by weighing a given volume (**15**). These methods are said to be slower and less accurate (**2,16**).

In addition, several papers (**17–23**), have appeared in which the procedure is simply to wet-screen the concrete into its approximate constituent portions, which are then dried and weighed. The sieves used are Nos. 4 and 100 (or 200).

Droege (**24**) alters the last-named procedure by first drying the sample, then "breaking it up with a blunt instrument" and sieving to separate the constituent factors.

It has also been reported (**19**) that the cement can be washed from the concrete sample by decantation and the amount thus determined. The aggregate may be determined, if desired, by sieve analysis, whereas chemical or physical methods are used to determine the water content.

Only two methods that differ from the above procedures were noted. In one (**26,27**) the specific gravity of a mixture of water and the portion of the concrete sample passing a No. 100 sieve is determined. Using certain apparatus

TABLE II.—DATA ON CONCRETE CONSTITUENTS.

Mixes

Cement Content	Cement, g	Sand, g	Gravel, g	Water, g
3 sacks per cu yd	122.5	598.8	866.3	127
4 sacks per cu yd	161.8	692.5	733.3	127
5½ sacks per cu yd	218.9	615.8	752.9	136
7 sacks per cu yd	278.0	543.4	766.2	150

All total 3.50 lb or 1587.6 g exclusive of water.

Elgin Sand Proportions

Cement Content	Cumulative Weights, lb for Indicated Sieve Range					
	Nos. 0 to 100	Nos. 0 to 50	Nos. 0 to 30	Nos. 0 to 16	Nos. 0 to 8	Nos. 0 to 4
3 sacks per cu yd	0.06	0.12	0.58	0.89	1.03	1.32
4 sacks per cu yd	0.07	0.13	0.67	1.04	1.20	1.53
5½ sacks per cu yd	0.06	0.12	0.60	0.92	1.06	1.36
7 sacks per cu yd	0.06	0.11	0.53	0.81	0.94	1.20

Cements

Series	Description	Specific Surface, sq cm per g[b]
Type I tests	Blend of four type I cements	1690
Type III tests	Long-time study cement No. 33, type III	2530
Air-entraining	Commercial brand, type IA	1759
Air-entraining	Long-time study cement No. 33T, type IIIA	2510
Specific surface	Special blend, type I[a]	1240
Specific surface	Special blend, type I[a]	2030
Comparison of types	Long-time study cement No. 12	1815
Comparison of types	Long-time study cement No. 22	1775
Comparison of types	Long-time study cement No. 42	1920
Comparison of types	Long-time study cement No. 51	2025

[a] Blend of basic research cements to produce specific surface indicated.
[b] Determined by turbidimeter. See ASTM Method of Test for Fineness of Portland Cement by the Turbidimeter (C 115-53), 1953 Supplement to Book of ASTM Standards, Part 3, p. 69.

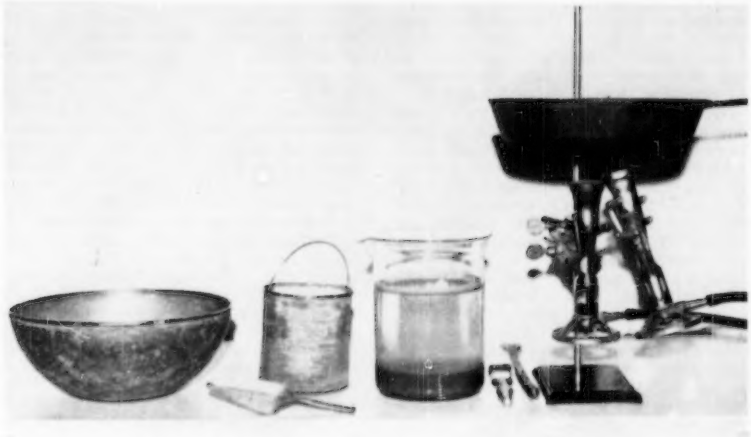

Fig. 1.—Laboratory Equipment Used in Test Procedure.
From left to right: receiving container, sampling scoop, 30-mesh basket, washing and settling beaker, brush, stirrer, cast iron skillet positioned over two Fisher burners.

and graphs, the cement content is related to the specific gravity. Correcting for material other than cement passing the No. 100 sieve is difficult and may limit field application. The other method (28) is one suggested by ASTM Committee C-12 on Mortars for Unit Masonry for possible use and further study. It covers the analysis of fresh mortar for its constituents, "sand, lime, and cement." The material is dried and sieved through a No. 200 sieve; the material passing the sieve is then centrifuged in a 250-ml bottle of water. The settled portion is dried, ground, and centrifuged in a 50-ml tube, with one drop of oleic acid and a bromoform-carbon tetrachloride mixture of 2.6 to 2.7 sp gr used as the separating medium. The lower (cement) portion of this second centrifuge step is dried and weighed.

Although this survey was primarily concerned with cement content, it was noted that an apparatus has been developed recently (29 34) which is reported to give the water-cement ratio. Actually a measure of the water content is found which can be interpreted as a water-cement ratio only if the mix is known.

In general it may be said that most of the methods described in this summary either (1) have not been widely adopted, (2) have not been extensively tested and studied for interferences and other limitations, or (3) are for the most part dependent upon the assumption that only cement passes the No. 100 sieve.

Experimental Approach

In reporting the test method as now developed, the experimental approach to the problem should be explained. Small batches of concrete of known weight (about 4 lb) and known cement content were prepared and used as "standard samples." These batches were subjected to a treatment (described in detail below) which resulted in separating the component parts of plastic concrete in such a manner that a measure of the volume of cement was obtained. The volume of cement so determined in each batch was then related graphically to the known cement content of each batch and a calibration curve was made available. Having established a calibration curve based upon this relationship, subsequent determinations of volume of cement in a given batch of unknown composition may be compared to the calibration curve and an estimation of the cement content arrived at by interpolation.

Materials Used

Aggregates were chosen as representative of several sources. The sources and the fineness moduli of the aggregates are shown in the first two columns of Table I.

The cements used were representative of types I, IA, II, III, IIIA, IV, and V. Also included were two experimental type I cements of widely differing specific surfaces. Notes on these cements are given in Table II.

Four different mixes were used for each aggregate and cement type combination, as recorded in Table II. With the exception of Elgin sand, the gradation of all sands was as occurred naturally. Elgin sand was graded and used in the proportions shown in Table II.

Two fly ashes were also used in the experiments—Chicago fly ashes, PCA lot Nos. 18800–2 and 18808. They were chosen because they had a wide range in their loss on ignition, 37.13 and 5.91 per cent, respectively.

The "heavy media" used was a liquid mixture of carbon tetrachloride (sp gr 1.59) and acetylene tetrabromide (sp gr 2.96). The specific gravity of the mixture used in the laboratory tests was 2.80. Because the vapors of carbon tetrachloride are dangerously toxic, a well-ventilated room is always required when working with this liquid. The heavy media is a colorless liquid mixture that does not react with cement, aggregate, or container.

Apparatus

Figure 1 shows the apparatus used in treating the sample up to the final separation, exclusive of the weighing balance.

In Fig. 2, showing the centrifuge and

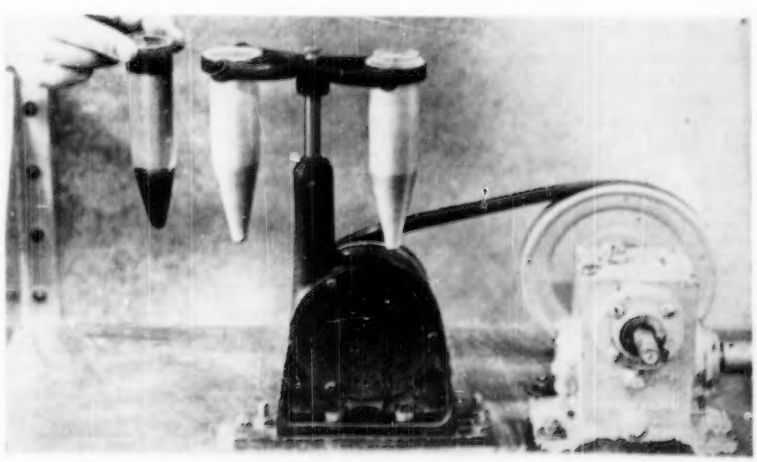

Fig. 2.—Laboratory Centrifuge Used in Test Procedure.

drive, a typical separation can be seen. The centrifuged cement appears as the dark lower layer, and the aggregate is the top layer.

Procedure for Making the Determination

In the laboratory experiments, concrete samples were prepared by combining sufficient cement and aggregate, in the proper proportions, to give dry samples of 3.5 lb, and containing the equivalent of 3, 4, 5½, or 7 sacks of cement per cu yd. The amount of water shown in Table II was added to the dry samples in a metal container. The sample was well stirred for a few minutes.

After mixing, the samples were allowed to hydrate for at least 1 hr (with infrequent stirring or light mixing during such period) after which the treatment was as follows:

A portion of the sample was transferred with a small scoop to a cylindrical basket (fabricated of 30-mesh brass screen stock) 4½ in. in diameter and 5 in. in height. The basket and its contents were shaken up and down in a 3000-ml beaker three-fourths full of water containing 1 g. of Dow Separan 2610 (a very effective flocculating agent). This process was repeated with successive portions until all the sample, including traces removed from the metal container by washing and brushing, had been so treated.

The beaker containing the water and material passing the No. 30 sieve was allowed to stand until the solids were well settled to the bottom (about 5 min). The supernatant water was then siphoned off or decanted carefully, avoiding loss of solid material. The small amount of material floating or suspended in the water was negligible.

The settled material was next transferred, with the aid of a brush, to a cast iron skillet (10-in. diameter). The burners were lighted and the material in the skillet allowed to dry at full heat for 45 min. After drying for 15 min, and until the heating time was over, the lumps were broken up occasionally to facilitate complete drying. The contents of the skillet were transferred to a large piece of glazed paper. A small brush assisted in transferring the last portions. The material on the paper was then poured into a weighing pan and weighed on an open pan or a trip balance.

From the weighed material, two samples of 25 g each were selected by taking small portions of the dried material from several parts of the balance pan. The samples were introduced into two graduated 50-ml centrifuge tubes. The centrifuge tubes were then filled, with stirring, to the 50-ml mark with the acetylene tetrabromide-carbon tetrachloride mixture described above and were placed in the centrifuge cups. The centrifuge was started slowly, by means of a powerstat, until full speed was reached. Full speed was about 1200 rpm which produced forces acting on the tip end of the centrifuge tube of the order of 100 times that of the force of gravity. After 3 min the centrifuge was stopped, and the top layers in the tubes were stirred with a metal rod. The centrifuging operation was repeated for 4 min, after which the tube was stirred as before. A final 4-min centrifuge period followed, making a total centrifuging time of 11 min. The volume of the cement layer was then recorded.

The time required to carry out the test procedure just described (exclusive of sample preparation) was about 1 hr, 15 min.

Calculation of Cement Content

A calculation is first made to determine the volume of the cement layer

TABLE III.—ERROR ANALYSIS.

The Table Below Gives the Individual Errors in Each of the Determinations Shown for Types I and III Cements in Table I. The Errors Are Found by Using Figs. 3 and 4. Two Centrifuge Tubes Were Used for Each Batch. Two Batches Were Tested for All Type I Experiments.

Aggregate Used	Fineness Modulus	Error in Individual Results for Mixes Indicated, sacks per cu yd								Average Error, sacks per cu yd
		3 sacks per cu yd		4 sacks per cu yd		5½ sacks per cu yd		7 sacks per cu yd		
		Tube No. 1	Tube No. 2	Tube No. 1	Tube No. 2	Tube No. 1	Tube No. 2	Tube No. 1	Tube No. 2	
Type I Cement										
Merrimac River Sand (lot No. 18896)	2.29	⅛ 0	⅛ 0	⅛ ⅛	⅛ ½	¼ ¼	⅛ ⅛	¼ ¼	0 ½	⅛
Hoot Pit Sand (lot No. 18556)	2.52	⅛ 0	0 ⅛	0 0	¼ ⅛	⅛ ⅛	⅛ ⅛	⅛ 0	0 0	⅛
Mississippi River Sand (lot No. 18897)	2.59	¼ ⅛	¼ 0	⅛ 0	0 0	⅛ 0	0 0	½ 0	¼ 0	⅛
Roquemore Sand (lot No. 18818)	2.75	0 0	⅛ ⅛	0 ¼	0 ½	⅛ 0	0 0	0 0	0 0	1/16
Seaboard (N. Y.) Sand (lot No. 18540)	2.77	0 0	0 ¼	⅛ ⅛	0 0	¼ ⅛	⅛ ⅛	½ ¼	¼ ¼	⅛
Elgin Sand	2.96	⅛ ¼	⅛ ½	0 ⅛	¼ ¼	0 ½	¼ ½	¼ ⅜	¼ ½	¼
Average error for type I		⅛		⅛		⅛		¼		
Average error of all type I tests = 0.14 sack per cu yd; standard deviation = 0.21 sack per cu yd										
Type III Cement										
Merrimac River Sand	2.29	0	0	0	¼	0	¼	⅛	⅛	⅛
Hoot Pit Sand	2.52	⅛	⅛	¼	¼	⅛	½	⅛	⅛	⅛
Mississippi River Sand	2.59	⅛	¼	0	0	⅛	⅛	¼	⅛	¼
Roquemore Sand	2.75	⅛	⅛	⅛	0	0	0	0	⅛	⅛
Seaboard (N. Y.) Sand	2.77	¼	¼	¼	⅛	0	0	¼	¼	⅛
Elgin Sand	2.96	½	¼	⅛	⅛	¼	⅛	⅛	¼	⅛
Average error for type III		⅛		⅛		⅛		⅛		
Average error of all type III tests = 0.22 sack per cu yd; standard deviation = 0.29 sack per cu yd										

Analysis of Error Distribution

Cement	Number of Results in Error Range Indicated					
	0 sack	⅛ sack	¼ to ⅛ sack	⅛ sack	⅛ to ¼ sack	Larger than ¼ sack
Type I	37	27	23	9	0	0
Type III	12	13	16	2	5	0

that would have been obtained if all of the dried minus No. 30 sieve material had been centrifuged, instead of the 25 g selected. This is hereafter referred to as the "equivalent volume."

The equivalent volumes so obtained are shown in the last four columns of Table I. The values shown under each mix are the equivalent volumes calculated from the volumes of the cement layer resulting after centrifuging two samples from each batch, one in each of the two tubes.

Figure 3 is the calibration curve for type I cement, that resulted from these computations; equivalent volumes are plotted against known cement contents. Each point on the curve is the average of 24 tests at each cement content indicated—3, 4, 5½, and 7 sacks per cu yd.

If the equivalent volumes given in Table I are located on the calibration curve, the individual cement contents may be determined by interpolation. The difference between the known and determined cement content is the error in an individual determination; these errors are shown in Table III. The results are actually deviations from the average, since all the results were used to plot the calibration curve.

As an example of how these results were obtained, the following will illustrate the procedure used for Meramec sand, type I cement, 3-sack mix:

Total weight of dried minus No. 30-sieve material	333.8 g
Weight of centrifuge samples	25.0 g
Volume of cement layer after centrifuging	8 ml (each tube)

$$\text{Equivalent volume} = \frac{(333.8) \times (8)}{(25)} = 107 \text{ ml}$$

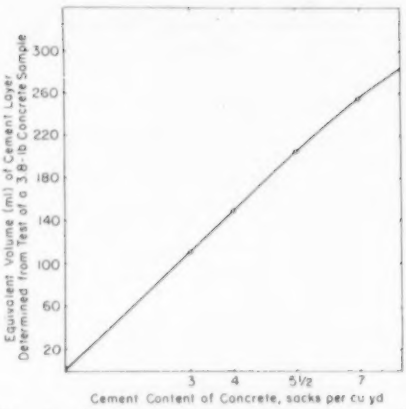

Fig. 3.—Calibration Curve for Type I Cement. Each point is the average of 24 values.

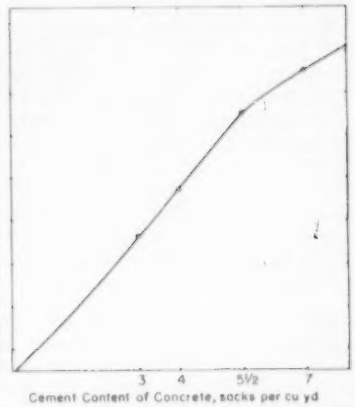

Fig. 4.—Calibration Curve for Type III Cement. Each point is the average of 12 values.

This value is shown in Table I. Locating 107 ml on the calibration curve in Fig. 3, a cement content of about 2¾ sacks per cu yd is indicated. The difference between the known cement content (3 sacks) and the determined cement content is ¼ sack per cu yd and is indicated in Table III.

From the data accumulated with the type I cement (96 tests in all), an average difference[2] was calculated to be 0.14 sack per cu yd and the standard deviation was 0.21 sack per cu yd.

Discussion

Type of Cement

With the exception of the influence of specific surface described below, the type of cement, *per se*, appears to have no significant effect upon the test results—based upon the data shown in Table IV which compares results obtained with types I, II, IV, and V cements.

The average difference of 0.21 sack per cu yd and the standard deviation of 0.26 sack per cu yd (for types I, II, IV, and V cements) compare favorably with the calculations for type I cement alone where the average difference was 0.14 sack per cu yd and the standard deviation 0.21 sack per cu yd.

Air Entrainment

Based upon the data in Table V, it is indicated that air entrainment has little influence on the test results when the entire range of cement contents tested is considered. In other words the ratio of type I to type IA results for the range from 3 to 7 sacks per cu yd is 0.98. The ratio of results of type III to type IIIA is 0.99.

[2] Defined as the difference between determined cement content and known cement content.

TABLE IV.—EFFECT OF TYPE OF CEMENT.

The Centrifugal Speed Was Not the Same as That Used in the Experiments of Table I; Therefore the Averages Cannot Be Compared.

Cement	Batch	Equivalent Volume of Cement Layer, ml							
		3 sacks per cu yd		4 sacks per cu yd		5½ sacks per cu yd		7 sacks per cu yd	
		Tube No. 1	Tube No. 2	Tube No. 1	Tube No. 2	Tube No. 1	Tube No. 2	Tube No. 1	Tube No. 2
Type I	No. 1	92	84	116	116	176	176	225	
	No. 2	98	98	121	121	165	165	206	225
Type II	No. 1	98	98	125	125	177	186	211	211
	No. 2	83	89	131	139	176	176	226	236
Type IV	No. 1	95	95	127	119	167	163	203	212
Type V	No. 1	90	93	123	120	164	164	217	217
Averages		93		124		171		217	

Error Analysis

		Error in Individual Results for Mixes Indicated, sacks per cu yd							
Type I	No. 1	0	¼	⅛	⅛	⅛	⅛	⅛	
	No. 2	¼	¼	⅛	⅛	⅛	⅛	⅛	¼
Type II	No. 1	¼	¼	¼	¼	¼	⅛	¼	¼
	No. 2	⅛	⅛	⅛	⅛	⅛	⅛	¼	⅛
Type IV	No. 1	⅛	⅛	¼	0	⅛	¼	⅛	¼
Type V	No. 1	⅛	0	⅛	0	⅛	⅛	0	0
Averages		⅛		¼		¼		¼	

Average error for all tests = 0.21 sack per cu yd; standard deviation = 0.26 sack per cu yd

Specific Surface of Cement

From the equivalent volumes shown in Table I, it is seen that concrete containing type III cement gave higher readings (at each mix tested) than did concrete containing type I cement. Speculation that the higher readings were caused by the higher specific surface of type III cement was confirmed in a series of tests comparing cements having a wide range of specific surface. These results are listed in Table VI and are shown graphically in Fig. 6.

Recognizing this disparity, one may improve the accuracy of estimating the cement content of concrete containing type III cement by using a calibration curve established from the data (for type III cement) in Table I. Such a curve is shown in Fig. 4. When this curve is used, the errors shown for type III cement in Table III are comparable to those for type I cement, namely, an average difference of 0.22 sack per cu yd and a standard deviation of 0.29 sack per cu yd.

Fine Aggregate

Although it was originally thought that the fineness of the sand would have an appreciable effect upon the accuracy of the test, the results do not show this. In the last column of Table III, the average error when using each of the sands is indicated. The error in each is about ¼ sack.

The negligible effect of fineness modulus is more clearly shown in Fig. 5. Here the equivalent volumes for mixes containing each sand are plotted against the cement content. The curves fall rather close together, with the exception of the one for Elgin sand. Further study of this point disclosed that specific gravity is the factor that causes the high results found for Elgin sand. Although the specific gravity of Elgin sand averaged about 2.77, the individual particles exhibited a wide range of specific gravity—and a number of the particles were in the range from 2.8 to 2.9 or higher. Some of the heaviest particles probably sank in the cement layer to produce the high results.

Heavy Media

The specific gravity of the heavy media mixture must be carefully adjusted so that it is high enough to float all the fine aggregate in the centrifuging operation. If this necessary condition does not prevail, some of the aggregate may be included in the cement layer and thereby cause the volume of cement to appear to be high.

Centrifugal Forces

The magnitude of the centrifugal forces acting upon the tubes during the centrifuging operation has an appreciable effect upon the degree of compaction and the cement layer. This fact was observed in the early experimental work and dictated the need for obtaining a constant centrifugal force by maintaining a constant speed of rotation. Speed was routinely checked with a tachometer.

Admixtures

It was of interest to see if the test was effective in concrete containing fly ash. Only a few tests were required to learn that the presence of fly ash created a new problem. When the test procedure as described was utilized and fly ash was introduced in amounts as small as 5 per cent, the fly ash, and cement did not separate from each other.

After considerable experimentation it was learned that separations of cement from the cement-fly ash-aggregate mixture were obtainable only when centrifugal forces acting upon the mixture were increased at least tenfold, that is, from about 100 gravities to about 1000 gravities. Such forces were not possible with the centrifuge shown in Fig. 2 but were obtained with a "clinical model" which was subsequently acquired to study this particular problem. Except for the fact that it is possible to say that separations can be made, there are no data available to present at this time. More extensive work is needed on this particular phase of the study.

Conclusions

Based upon the laboratory work reported here, the following conclusions can be drawn:

1. When considered on its own merits and adequacy as a test, the

TABLE V.—EFFECT OF AIR-ENTRAINING CEMENTS.[a]

Comparison of Air-Entraining and Nonair-Entraining Cements. The Centrifugal Speed Was Not the Same as That Used in the Experiments of Table I; Therefore the Averages Cannot Be Compared.

Cement	Equivalent Volumes, ml, and Ratios for Mixes Indicated			
	3 sacks per cu yd	4 sacks per cu yd	5½ sacks per cu yd	7 sacks per cu yd
Type I	117	147	194	260
Type IA	117	140	215	269
Ratio type I to type IA	1.00	1.05	0.90	0.97
Type III	122	180	244	284
Type IIIA	127	175	227	311
Ratio type III to type IIIA	0.96	1.03	1.07	0.91

[a] The equivalent volumes listed are averages of two or more values.

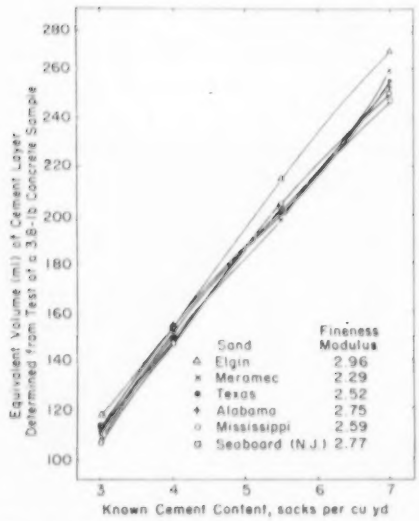

Fig. 5.—Effect of Aggregate Fineness on the Equivalent Volume of Type I Cement.

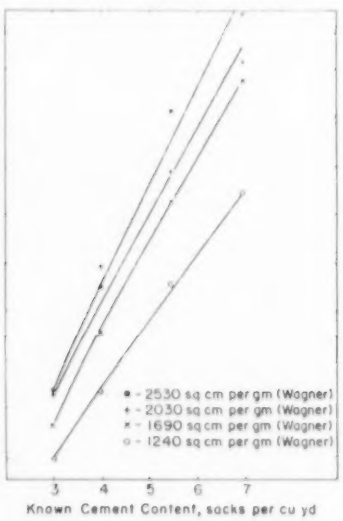
• - 2530 sq cm per gm (Wagner)
+ - 2030 sq cm per gm (Wagner)
× - 1690 sq cm per gm (Wagner)
○ - 1240 sq cm per gm (Wagner)
3
4
5
6
7
Known Cement Content, sacks per cu yd

Fig. 6.—Effect of Specific Surface of the Cement on the Equivalent Volume of the Cement Layer. Plotted values are the average of from 4 to 24 determinations as indicated in Table I.

TABLE VI.—EFFECT OF FINENESS.

In Addition to the Two Cements Used in the Experiments in Table I, Two Special Cements Were Prepared to Have the Fineness Shown. Two 25-g Samples Were Used from Each of Two Batches per Mix.

Cement Fineness (Wagner), sq cm per g	Equivalent Volume of Cement Layer, ml							
	3 sacks per cu yd		4 sacks per cu yd		5½ sacks per cu yd		7 sacks per cu yd	
	Tube No. 1	Tube No. 2	Tube No. 1	Tube No. 2	Tube No. 1	Tube No. 2	Tube No. 1	Tube No. 2
1240	98	98	123	123	170	170	205	210
	100	100	129	129	169	169	208	208
1690 (Type I Average—Table I)	112		151		204		255	
2030	124	127	173	177	209	209	259	259
	125	125	180	180	223	227	272	266
2530 (Type III Average—Table I)	126		169		242		283	

method appears to be relatively accurate and reliable.

2. Successful application of the test to field work is likely to be very largely dependent upon acceptable sampling techniques and the use of calibration curves which would be established for the local area in which testing is being done.

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Influence of Composition on Measured Motor Oil Viscosity at 0 F

By R. W. Foreman

Measurements of 0 F viscosity of several oil blends using a rotational viscometer show that viscosity index improvers effect a pronounced viscosity increase over that expected from ASTM extrapolation.

0 F VISCOSITY used for current SAE crankcase oil classification is obtained through extrapolation of 100 and 210 F viscosity values using ASTM standard viscosity temperature charts (D 341).[1] In an earlier paper, the author[2] showed 0 F viscosities of then current motor oils measured in a rotational viscometer to be generally lower than ASTM extrapolated viscosities. The same paper showed capillary viscometers to be unreliable for 0 F viscosity measurements.

The advent of cross-graded motor oils such as 5W-20 and 10W-30 in the past two years stimulated further investigation of measured 0 F viscosities. Since these oils generally employ greater amounts of viscosity index (V.I.) improver and other additives than previous motor oils, it was desired to ascertain the influence of these additives on the measured 0 F viscosities. The results presented in this paper demonstrate that the effect of V.I. improvers is pronounced and is in the direction of increased 0 F viscosity with greater amounts of improver.

Apparatus

The temperature bath used for the measurements presented in this paper is identical to the one described and illustrated in Fig. 2 of the earlier paper.[2] The temperature was regulated to ±0.2 F as before.

The viscometer used for the measurements in the present investigation is basically the same as described and illustrated in Fig. 2 of the previous paper. The grooved aluminum bob was replaced by a similarly dimensioned plastic bob carefully machined from a solid block of thermally set laminated plastic (purchased from Synthane Corp.). The bob grooves and cup screen were eliminated after experiments demonstrated that no surface slippage occurred in measuring these low temperature oils. It was determined by careful thermocouple measurements at the bob surface that the plastic bob eliminated a temperature gradient through the oil which resulted from the high heat conductivity of the original aluminum bob coupled with low heat conductivity through the oil. A further innovation was the covering of the cup with plastic covers, thus reducing heat transfer even more and preventing condensation in the oils.

Experimental Procedure

Calibration

Calculation of viscosity and shear rate from instrument dimensions, using the general equation for rotational viscometers described in the previous paper, probably gives rise to some error due to neglect of end effect. No adequate mathematical treatment has yet been given for the contribution of end effect. Fisher and Lindsley[3] have discussed this problem in considerable detail. To compensate for possible end effects, the viscometer used in this work was calibrated with A.P.I. standard oil Beta-53, at 100 and 50 F. The instrument constant thus obtained was used for calculation of the viscosity of oils at 0 F according to the following equation:

$$\eta_0 = 0.01863 \times G/B$$

where:

η_0 = absolute viscosity in poises,
G = weight on pulley in grams,
B = angular velocity of bob in revolutions per second, and
0.01863 = average instrument constant calculated from measurements and the accurately known viscosity and density of Beta-53 oil at 50 and 100 F.

Shear rates were not calculated for individual measurements in this work but were known to fall within the range of 1.5 to 60 sec^{-1}.

Procedure

The same procedure as described in the previous paper was used except for the addition of sufficient oil to cover the bob completely. This was done in calibration also and eliminated any possible error due to incomplete coverage of bob surface.

Samples

The base oils used for preparation of the blends included in this study were all solvent-extracted (furfural) and dewaxed (MEK) distillate fractions of Mid-Continent-type crude. The base oil was sampled from normal refinery production. Three types of additives were employed in preparing most of the blends. One was a commercial V.I. improver of the polymethacrylate type; another was a commercial V.I. improver and dispersant designated in this paper as a modified polymethacrylate; and the third additive was a solvent-extracted and dewaxed residual bright stock having a 210 F viscosity of approximately 250 Saybolt Universal seconds (SUS). In addition to these additives, one blend was prepared using a commercial V.I. improver of the polyisobutylene type. Blending was accomplished by weighing in each component and agitating the blends for considerable periods of time to assure homogeneity. Weights were converted to volume per cent at 60 F using specific gravity for the calculation.

Inspection data consisting of density at 0 F, viscosity at 100 and 210 F, and viscosity index measured by conventional methods are presented in Table I for all base oils and blends.

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[1] Standard Viscosity-Temperature Charts for Liquid Petroleum Products (D 341 – 43), 1952 Book of ASTM Standards, Part 5, p. 167.

[2] R. W. Foreman, "Measurements of Motor Oil Viscosity at 0 F," ASTM BULLETIN, No. 191, July, 1953, p. 50 (TP94).

[3] E. K. Fisher and C. H. Lindsley, "End-Effect in Rotational Viscometer," *Journal of Applied Physics*, Vol. 18, p. 988 (1947).

Results

Graphs of experimental viscometer data were prepared for each sample plotting revolutions per second on the ordinate and pulley weight on the abscissa. Linear plots resembling closely those shown in Figs. 4, 5, and 6 of the previous paper[2] were obtained in all cases, attesting to Newtonian liquid behavior at 0 F.

0 F viscosity data for all the oils and blends appear in Tables II to V. These tables show volume per cent of additive, 0 F viscosity in SUS from measurements in the Stormer rotational viscometer, and the ratio of Stormer viscosity to the ASTM extrapolated viscosity at 0 F. Table II contains data for blends containing V.I. improver of the polymethacrylate type. Table III presents data for blends containing both V.I. improver of the polymethacrylate type and of the modified polymethacrylate type, which is a combination V.I. improver and dispersant. Table IV shows the data for blends containing solvent-extracted residual bright stock in addition to polymethacrylate V.I. improver. Data for a blend containing a V.I. improver of the polyisobutylene type is presented in Table V.

Figures 1 to 3 (data taken from Tables II through IV) show graphically the effect of additives on the ratio of measured-to-extrapolated 0 F viscosity. The data clearly indicate that V.I. improvers of the polymethacrylate type cause a pronounced increase in the 0 F viscosity to be expected from extrapolation of higher temperature viscosities. As reported in the previous paper, solvent-extracted base oils have 0 F viscosities as much as 35 per cent lower than expected from extrapolation. In the range of 7 to 9 per cent V.I. improver of the polymethacrylate type, the 0 F viscosity is as much as 50 per cent higher than extrapolated viscosity. The ratio of measured viscosity to extrapolated is approximately doubled over that for the base oil by adding 7 to 9 per cent V.I. improver. Modified polymethacrylate appears to have an equivalent effect, judging from Fig. 2.

Solvent-extracted residual bright stock appears to have no significant influence on the ratio of measured-to-extrapolated 0 F viscosity, according to Fig. 3. The graphs of polymethacrylate content *versus* measured-to-extrapolated viscosity are nearly superimposable for blends with and without solvent-extracted residual bright stock.

Oil No. 21 in Table V indicates that polyisobutylene type V.I. improver causes a significant increase in 0 F viscosity over that expected from extrapolation, although the increase appears to be less on a volume per cent basis

TABLE I.—INSPECTION DATA FOR BASE OILS AND BLENDS.

Oil	Density at 0 F	Viscosity, SUS		Viscosity Index
		At 100 F	At 210 F	
No. 1	0.8804	142.2	42.00	(81)[a]
No. 13	0.8928	305.6	52.60	97
No. 20	0.8840	274.6	50.96	98
Blend (See Tables II to V for composition)				
No. 2	0.8860	212.1	50.90	132
No. 3	0.8897	175.8	51.43	154
No. 4	0.8887	329.9	68.67	146
No. 5	0.8863	262.7	68.45	158
No. 6	0.8956	393.6	78.37	146
No. 7	0.8890	213.0	50.70	130
No. 8	0.8892	181.2	51.26	151
No. 9	0.8876	537.8	77.74	127
No. 10	0.8921	334.5	68.22	144
No. 11	0.8901	383.5	78.33	148
No. 12	0.8879	261.3	67.82	158
No. 14	0.8906	210.2	51.10	134
No. 15	0.8859	175.8	51.43	154
No. 16	0.8963	518.4	78.21	130
No. 17	0.8893	326.6	68.45	146
No. 18	0.8929	401.9	78.84	146
No. 19	0.8904	267.3	68.45	157
No. 21	0.8861	299.8	58.50	131

[a] Inaccurate V.I. range.

TABLE II.—DATA FOR OIL BLENDS CONTAINING POLYMETHACRYLATE IN SOLVENT-EXTRACTED NEUTRAL BASE.

Oil	Grade	Volume of Polymethacrylate, per cent	η_0 Stormer, SUS	η_0 Stormer / η_0 Extrapolated
No. 1	10W	0	5 600	0.65
No. 2	10W-20	3.0	7 960	1.00
No. 3	5W-20	5.2	4 660	1.17
No. 4	10W-30	7.8	11 550	1.56
No. 5	5W-30	11.6	5 840	1.62
No. 6	10W-40	10.2	12 700	1.53

TABLE III.—DATA FOR OIL BLENDS CONTAINING MODIFIED POLYMETHACRYLATE PLUS POLYMETHACRYLATE IN SOLVENT-EXTRACTED NEUTRAL BASE.

All blends contain 3.7 per cent, by volume, modified polymethacrylate.

Oil	Grade	Total Volume of Polymethacrylate, per cent	η_0 Stormer, SUS	η_0 Stormer / η_0 Extrapolated
No. 7	10W-20	4.5	9 040	1.08
No. 8	5W-20	6.7	5 110	1.25
No. 9	20W-40	7.2	34 700	1.34
No. 10	10W-30	9.7	11 500	1.44
No. 11	10W-40	11.7	11 650	1.48
No. 12	5W-30	12.8	6 320	1.72
No. 13	20W	0	20 230	0.72

TABLE IV.—DATA FOR OIL BLENDS CONTAINING POLYMETHACRYLATE PLUS SOLVENT-EXTRACTED RESIDUAL BRIGHT STOCK.

All blends contain 5.0 per cent, by volume, solvent-extracted residual bright stock.

Oil	Grade	Volume of Polymethacrylate, per cent	η_0 Stormer, SUS	η_0 Stormer / η_0 Extrapolated
No. 14	10W-20	3.0	7 775	1.03
No. 15	5W-20	5.0	4 760	1.36
No. 16	20W-40	5.8	27 070	1.18
No. 17	10W-30	7.7	11 750	1.61
No. 18	10W-40	10.2	14 300	1.57
No. 19	5W-30	11.5	6 220	1.60
No. 20	20W	0	17 950	0.80

TABLE V.—DATA FOR ONE OIL BLEND CONTAINING POLYISOBUTYLENE IN SOLVENT-EXTRACTED NEUTRAL BASE.

Oil	Grade	Volume of Polyisobutylene, per cent	η_0 Stormer, SUS	η_0 Stormer / η_0 Extrapolated
No. 21	10W	10.0	13 510	1.25

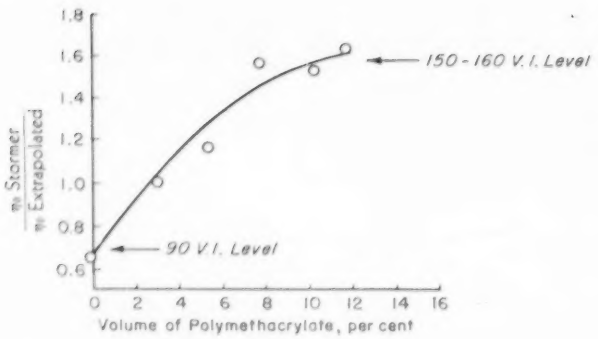

Fig. 1.—Effect of Polymethacrylate on Measured 0 F Viscosities of 5W and 10W Oil Blends. Solvent-extracted neutral base oils. (Refer to Table I.)

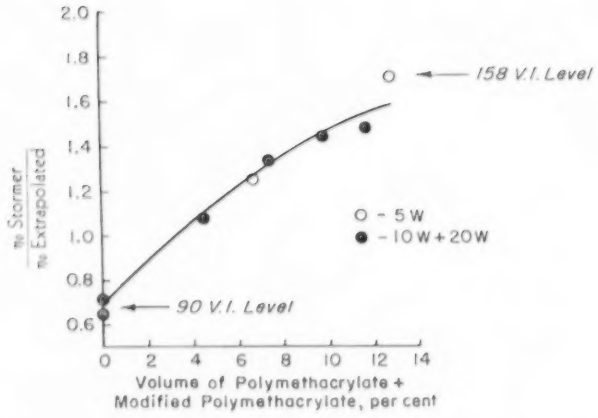

Fig. 2.—Effect of Modified Polymethacrylate and Polymethacrylate on Measured 0 F Viscosities of 5W, 10W, and 20W Oil Blends. Solvent-extracted neutral base oils. (Refer to Table II.)

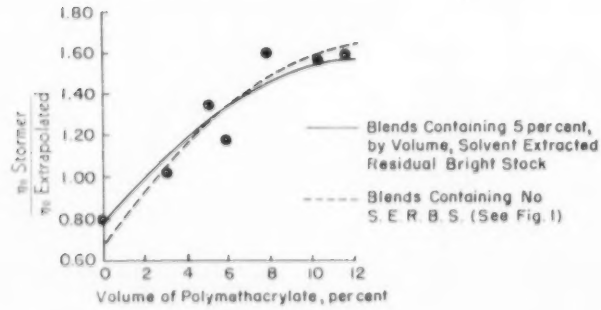

Fig. 3.—Effect of Solvent-Extracted Residual Bright Stock on Measured 0 F Viscosities of 5W, 10W, and 20W Oil Blends Containing Polymethacrylate. (Refer to Table III.)

than for polymethacrylate-type V.I. improver. On an equivalent V.I. basis, the two types of V.I. improver probably have nearly the same influence on the measured-to-extrapolated ratio. This conclusion is based on a single sample, however, and is therefore tentative.

Discussion of Results

It is apparent from this study that extrapolated 0 F viscosity is an unreliable measure of true 0 F viscosity, particularly for oils containing substantial amounts of V.I. improver. All of the 5W cross-graded oils included in this study have measured 0 F viscosities exceeding the maximum (4000 SUS) set forth in SAE specifications.[4] Some of the 10W oils exceed the 12,000 SUS maximum, and all but three are very close to this maximum. 0 F viscosity specifications would reflect cold starting performance much better if they were based on measured rather than extrapolated values. The rotational viscometer used in this work offers a convenient method and is recommended for making these measurements.

Summary

Measurements of 0 F viscosity of several oil blends using a rotational viscometer show that V.I. improvers effect a pronounced viscosity increase over that expected from ASTM extrapolation. Solvent-extracted base oils have measured-to-extrapolated 0 F viscosity ratios of 0.65 to 0.80. Addition of 7 to 9 per cent of polymethacrylate-type V.I. improvers approximately doubles this ratio. Solvent-extracted residual bright stock does not measurably affect the ratio. Measured 0 F viscosity specifications are recommended over those based on extrapolated values, since only by measurement can true 0 F viscosity and hence cold starting performance be ascertained.

Acknowledgment:

The author is indebted to E. C. Hughes for valuable advice and to R. Grasselli for conducting experimental work.

[4] "SAE Handbook," Soc. Automotive Engrs., p. 296 (1952).

Mooney Viscometer Cure Characteristics of Hevea Rubber (Results of an Interlaboratory Test)

By G. E. Decker and J. Mandel

The results of an interlaboratory test show that the Mooney viscometer is a practical instrument for determining the cure characteristics of rubber compounds.

THE classification of natural rubber with respect to its vulcanization characteristics has been under investigation by Subcommittee XII on Crude Natural Rubber, ASTM Committee D-11 on Rubber and Rubber-Like Materials, for some time. Workers at the B. F. Goodrich Co. (1,2)[1] have proposed the use of the Mooney viscometer for this purpose. Stiehler and Roth (3) have also recommended this method. Accordingly, Subcommittee XII appointed a task group under the chairmanship of A. E. Juve to conduct an interlaboratory test to determine the utility of this method for the classification of natural rubber. The National Bureau of Standards was assigned the responsibility of designing the test, preparing the samples, and analyzing the data. The present paper reports the results of this interlaboratory test.

Procedure

Samples of pale crepe and of each of the three technically classified rubbers (red, yellow, and blue) were selected to cover a range of cure characteristics. The four samples were compounded in accordance with the ACS-I recipe and the mixing procedure in ASTM Methods D 15–54 T.[2] Circular specimens were prepared and sealed in ointment tins to reduce the effect of varying ambient humidity conditions during transit and in the various laboratories.

The tests were conducted in accordance with the statistical plan given in Table I. This plan required the testing of a specimen from each of the four rubbers on each of four days by each of the five laboratories. The integral (one-piece) dies described elsewhere (4) were used on days 1 and 3, and the standard dies, which are furnished as original equipment on the Mooney viscometer, were used on days 2 and 4. The 20 specimens of each compound were allocated at random to the positions designated in Table I.

The procedure used in each laboratory was as follows:

1. The Mooney viscometer used for this study was calibrated and adjusted according to the method given in ASTM Method D 927–53 T.[3]

2. The test temperature was 125 C as determined by thermocouples. When the standard (two-piece) dies were used, the method given in ASTM Method D 1077 – 49 T[4] was followed; when the

TABLE I.—PLAN USED FOR CONDUCTING EXPERIMENTS.

Laboratory	Day	Die	Test No. 1[a]	Test No. 2[a]	Test No. 3[a]	Test No. 4[a]
I and II	1	Integral	R	P	B	Y
	2	Standard	Y	R	P	B
	3	Integral	P	B	Y	R
	4	Standard	B	Y	R	P
III	1	Integral	Y	R	P	B
	2	Standard	B	Y	R	P
	3	Integral	R	P	B	Y
	4	Standard	P	B	Y	R
IV	1	Integral	B	Y	R	P
	2	Standard	P	B	Y	R
	3	Integral	Y	R	P	B
	4	Standard	R	P	B	Y
V	1	Integral	P	B	Y	R
	2	Standard	R	P	B	Y
	3	Integral	B	Y	R	P
	4	Standard	Y	R	P	B

[a] R = Technically Classified Red; P = Pale Crepe; B = Technically Classified Blue; Y = Technically Classified Yellow.

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[1] The boldface numbers in parentheses refer to the list of references appended to this paper.

[2] Tentative Methods of Sample Preparation for Physical Testing of Rubber Products (D 15 – 52 T), 1952 Book of ASTM Standards, Part 6, p. 1.

[3] Tentative Method of Test for Viscosity of Rubber and Rubber-Like Materials by the Shearing Disk Viscometer (D 927 – 52 T), 1952 Book of ASTM Standards, Part 6, p. 399.

[4] Tentative Method of Test for Curing Characteristics of Vulcanizable Mixtures During Heating by the Shearing Disk Viscometer (D 1077 – 49 T), 1952 Book of ASTM Standards, Part 6, p. 483.

TABLE II.—TIME OF INCIPIENT CURE (t_5).[a]

Rubber	Die	Day	t_5, min				
			Lab. I	Lab. II	Lab. III	Lab. IV	Lab. V
Red	Integral	1	12.02	11.90	11.58	11.50	11.97
		3	11.30	11.65	12.68	11.15	11.43
		Mean	11.66	11.78	12.13	11.32	11.70
	Standard	2	12.17	12.80	12.00	12.00	12.87
		4	11.65	12.60	11.80	12.65	13.30
		Mean	11.91	12.70	11.90	12.32	13.08
Pale Crepe	Integral	1	8.30	8.70	8.40	8.42	8.56
		3	8.10	8.80	8.40	7.92	8.55
		Mean	8.20	8.75	8.40	8.17	8.56
	Standard	2	8.50	9.75	8.20	9.24	9.53
		4	8.67	8.90	8.56	9.00	9.80
		Mean	8.58	9.32	8.38	9.12	9.67
Yellow	Integral	1	8.20	8.85	8.30	7.83	8.05
		3	7.72	8.50	8.80	7.61	8.37
		Mean	7.96	8.68	8.55	7.72	8.21
	Standard	2	8.28	9.20	8.60	8.50	9.10
		4	8.25	9.20	8.40	8.17	9.05
		Mean	8.26	9.20	8.50	8.34	9.08
Blue	Integral	1	3.40	4.20	3.40	3.58	3.53
		3	3.36	3.75	3.60	3.40	3.43
		Mean	3.38	3.98	3.50	3.49	3.48
	Standard	2	3.62	4.30	3.60	3.78	4.10
		4	3.62	3.95	3.95	3.73	4.34
		Mean	3.62	4.12	3.78	3.76	4.22

[a] Time for Mooney viscosity to increase five units above minimum.

TABLE III.—INVERSE RATE OF CURE (Δt).[a]

Rubber	Die	Day	Δt, min				
			Lab. I	Lab. II	Lab. III	Lab. IV	Lab. V
Red	Integral	1	3.41	3.50	3.44	3.16	3.48
		3	3.40	3.45	3.47	3.17	3.40
		Mean	3.40	3.48	3.46	3.16	3.44
	Standard	2	3.63	3.50	3.60	3.66	3.82
		4	3.40	3.85	3.67	3.55	3.70
		Mean	3.52	3.68	3.64	3.60	3.76
Pale Crepe	Integral	1	2.46	2.60	2.70	2.43	2.58
		3	2.52	2.95	2.64	2.38	2.73
		Mean	2.49	2.78	2.67	2.40	2.66
	Standard	2	2.70	2.65	2.60	2.36	2.71
		4	2.65	2.70	2.71	2.74	2.80
		Mean	2.68	2.68	2.66	2.55	2.76
Yellow	Integral	1	2.06	2.25	2.20	1.92	2.05
		3	2.06	2.25	2.26	1.92	2.14
		Mean	2.06	2.25	2.23	1.92	2.10
	Standard	2	2.25	2.40	2.20	2.30	2.23
		4	2.25	2.40	2.28	2.30	2.21
		Mean	2.25	2.40	2.24	2.30	2.22
Blue	Integral	1	1.40	1.50	1.50	1.40	1.42
		3	1.43	1.65	1.50	1.33	1.42
		Mean	1.42	1.58	1.50	1.36	1.42
	Standard	2	1.53	1.70	1.50	1.55	1.61
		4	1.50	1.75	1.55	1.52	1.56
		Mean	1.52	1.72	1.52	1.54	1.58

[a] Time for Mooney viscosity to increase from 5 to 35 units above minimum.

integral (one-piece) dies were used, the test temperature was determined by thermocouples placed in the wells that were provided in the dies.

3. Each ointment tin contained one test specimen. The tin was opened not sooner than 15 min before the specimen was placed in the Mooney viscometer for testing.

4. With the temperature of the Mooney viscometer in the steady-state condition, the time for opening the dies, placing the specimen in the machine, and closing the dies was held at a maximum of 20 sec. The specimen was allowed to heat for 60 sec after closing the dies; then the motor was started.

5. The Mooney viscometer was allowed to run until the viscosity increased 40 units above the minimum. Four of the five laboratories recorded the Mooney viscosity on autographic strip-chart recorders. The fifth laboratory obtained Mooney viscometer readings every 10 sec during the test. The recorder charts and the 10-sec readings were sent to the National Bureau of Standards for statistical analysis.

6. All of the viscometers used in this study were heated with steam.

Results and Discussion

The results obtained from this study are given in Tables II to V. Table VI summarizes the statistical analysis of the data for t_5 (time of incipient cure), Δt (inverse rate of cure), and t_p (time of preferred cure). The standard deviations corresponding to the residual mean squares in Table VI are 0.23, 0.084, and 1.3 min, respectively. These values reflect the experimental error within a single laboratory using the same die.

Table VI shows that among the main effects only the mean squares for "days" are not significant with respect to the residual mean squares. Thus, the variability of measurements made on different days is not substantially larger than that of measurements made on the same day.

It is interesting to observe that while significant differences exist between the results obtained in different laboratories (main effect for "laboratories"), the interaction "samples × laboratories" is nonsignificant for all three tests. This indicates that the systematic differences between laboratories are essentially consistent for all samples. Thus, if results were expressed relative to a reference material tested simultaneously with the samples, the various laboratories would agree within experimental error. It follows from the magnitude of the "laboratories" mean squares that, in the absence of a reference material, the error of test is approximately double because of the variability among laboratories (error expressed as variance).

The interactions "samples × dies" and "laboratories × dies" are significant, indicating that the effect of dies is not entirely consistent from sample to sample or from laboratory to laboratory. However, the increase in experimental error resulting from these interactions is relatively small. The estimated standard deviations for experimental error including these interactions are 0.36 min for t_5, 0.11 min for Δt, and 1.8 min for t_p.

The main effect for dies is highly significant. The values of t_5, Δt, and t_p for the standard die (die II) are invariably higher than those for the integral die (die I). This result substantiates the more rapid heat transfer

TABLE IV.—MINIMUM MOONEY VISCOSITY.

Rubber	Die	Day	Minimum Mooney Viscosity				
			Lab. I	Lab. II	Lab. III	Lab. IV	Lab. V
Red	Integral	1	38.8	37.1	40.3	39.5	40.3
		3	39.2	38.5	41.8	41.0	40.3
		Mean	39.0	37.8	41.0	40.2	40.3
	Standard	2	39.0	37.3	40.0	39.0	40.3
		4	38.9	37.0	39.5	38.0	39.1
		Mean	39.0	37.2	39.8	38.5	39.7
Pale Crepe	Integral	1	43.0	41.0	45.0	43.5	44.0
		3	42.7	42.0	45.5	45.0	44.0
		Mean	42.8	41.5	45.2	44.2	44.0
	Standard	2	42.5	41.0	44.0	38.0	40.3
		4	42.5	41.3	42.0	42.0	42.7
		Mean	42.5	41.2	43.0	40.0	41.5
Yellow	Integral	1	41.8	40.0	43.4	43.0	43.1
		3	42.1	41.3	44.5	44.5	42.7
		Mean	42.0	40.6	44.0	43.8	42.9
	Standard	2	41.3	39.9	43.0	41.0	42.1
		4	41.7	40.0	42.5	41.0	41.6
		Mean	41.5	40.0	42.8	41.0	41.8
Blue	Integral	1	47.5	45.5	48.8	48.5	49.0
		3	47.9	47.3	51.5	50.5	48.4
		Mean	47.7	46.4	50.2	49.5	48.7
	Standard	2	47.5	47.0	49.0	47.0	48.3
		4	47.9	46.0	50.0	47.5	48.0
		Mean	47.7	46.5	49.5	47.2	48.2

TABLE V.—OPTIMUM CURE (t_p).[a]

Rubber	Die	Day	t_p, min				
			Lab. I	Lab. II	Lab. III	Lab. IV	Lab. V
Red	Integral	1	63.17	64.40	63.18	58.90	64.17
		3	62.30	63.40	64.73	58.70	62.43
		Mean	62.74	63.90	63.96	58.80	63.30
	Standard	2	66.62	65.30	64.73	66.90	70.17
		4	62.65	70.35	66.85	65.90	68.80
		Mean	64.64	67.82	65.79	66.40	69.48
Pale Crepe	Integral	1	45.20	47.70	48.90	44.87	47.26
		3	45.90	53.05	48.00	43.62	49.50
		Mean	45.55	50.38	48.45	44.24	48.38
	Standard	2	49.00	49.50	47.20	44.64	50.18
		4	48.42	49.40	49.21	50.10	51.80
		Mean	48.71	49.45	48.20	47.37	50.99
Yellow	Integral	1	39.10	42.60	41.30	36.63	38.80
		3	38.62	42.25	42.79	36.41	40.47
		Mean	38.86	42.42	42.00	36.52	39.64
	Standard	2	42.03	45.20	41.60	43.00	42.55
		4	42.00	45.20	42.60	42.67	42.20
		Mean	42.02	45.20	42.10	42.88	42.38
Blue	Integral	1	24.40	26.70	25.90	24.58	24.83
		3	24.81	28.50	26.10	23.35	24.73
		Mean	24.60	27.60	26.00	23.96	24.78
	Standard	2	26.57	29.80	26.10	27.03	28.25
		4	26.12	30.20	27.20	26.53	27.74
		Mean	26.34	30.00	26.65	26.78	28.00

[a] $t_p = t_s + 15\Delta t$.

TABLE VI.—SUMMARY OF ANALYSES OF VARIANCE.

Source of Variation	Degrees of Freedom	Mean Squares		
		t_s	Δt	t_p
Main Effects:				
Samples	3	234.1063	13.9892	5024.0446
Laboratories	4	1.2488	0.1056	33.9420
Dies	1	5.2633	0.4590	151.6628
Days	10[b]	0.1369	0.0089	1.9717
Interactions:				
Samples × laboratories	24[b]	0.0732	0.0071	1.8435
Samples × dies	3	0.1112	0.0313	7.0586
Laboratories × dies	4	0.6181	0.0312	11.0338
Residual[c]	30	0.0542	0.0070	1.7198

[a] Each laboratory provides 2 degrees of freedom for days, since all samples were tested on each of two days for each of the two dies.
[b] Twelve degrees of freedom for each of the two dies.
[c] Variability of single measurements made on the same samples in the same laboratory using the same die.

in die I than in die II. It indicates the need for more explicit specifications for the dies used in the Mooney viscometer.

The effect of samples is, of course, highly significant since the samples were selected to cover a wide range of values. However, the values for t_5 corresponding to samples "Pale Crepe" and "Technically Classified Yellow" are close. Calculations show that in order to detect the relatively small difference between these two samples a minimum of six measurements of t_5 on each of the two materials is required (95 per cent confidence). In the case of Δt and t_p a single measurement on each material will differentiate between them. From the standard deviations derived from the data, it can be inferred that the minimum difference between any two materials, which a single measurement on each of the two materials will detect with 95 per cent confidence, is 0.64 min for t_5, 0.23 min for Δt, and 3.6 min for t_p. These values also represent the uncertainty in the classification of a rubber relative to a reference material on the basis of a single measurement of each.

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(2) A. G. Veith, "Technically Classified Rubber—The Non-Rubber Content and the Measurement of Cure Rate," Symposium on Recent Developments in the Evaluation of Natural Rubber, Am. Soc. Testing Mats., p. 33 (1953). (Issued as separate publication *ASTM STP No. 136.*) *Rubber Chemistry and Technology*, Vol. 26, p. 655 (1953).

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Comparison of Methods for Measuring the Tensile and Tear Properties of Plastic Films

By Frank W. Reinhart and John Mandel

Editor's Note.—The plan of evaluation, data, and interpretations presented in this report are the result of the combined efforts of the following individuals working under the general supervision of Group II of the Plastic Film, Sheeting, and Coated Fabrics Division of the Society of the Plastics Industry, David S. Plumb, chairman; (T. S. Lawton is the present chairman of Group II. Both Mr. Plumb and Mr. Lawton are from the Plastics Division, Monsanto Chemical Co.):

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DURING the course of the technical work by the Society of the Plastics Industry on the preparation of Commercial Standard CS 192-53 for General Purpose Vinyl Plastic Film, problems arose concerning the relations between tensile strength and tear resistance and the variations allowed in ASTM Tentative Methods of Test for Tensile Properties of Thin Plastic Sheets and Films (D 882),[1] and Tentative Method of Test for Tear Resistance of Plastic Film and Sheeting (D 1004.)[2]

Some had the opinion that tensile strength and tear resistance were measurements of the same properties and consequently one could be substituted for the other. Others thought that the SPI-ASTM tear resistance test (D 1004)[2] and the Elmendorf tearing test measured two aspects of tearing that were closely related. From the reports from various laboratories, it was evident that reproducible results between laboratories were not being obtained when the testing was done in accordance with ASTM Tentative Methods D 882 and D 1004. This was attributed to variables that were not specified in these methods. To clarify these problems, a round-robin testing program was organized by Group II of the Plastic Film, Sheeting, and Coated Fabrics Division of the Society of the Plastics Industry. The following specific points required clarification:

1. The relations between the tensile strength, tensile elongation, SPI-ASTM tear resistance, and Elmendorf tearing resistance of plastic films.
2. The effects of the variations permitted in ASTM Methods D 882 and D 1004, and those arising from the use of different types of testing machines on the tensile strength, tensile elongation, and SPI-ASTM tear resistance of plastic films.
3. The reproducibility of the values for tensile strength, tensile elongation, and tear resistance of plastic films obtained by different laboratories with machines of the same type.
4. The feasibility of using for specification purposes all the various procedures and machines permitted in ASTM Methods D 882 and D 1004 to test vinyl and polyethylene plastic films.

The plan of work was organized under the guidance of a statistician so that the objectives of the work could be obtained without making an unduly large number of tests.

Four vinyl plastic films that varied in tensile and tear properties and one polyethylene film were selected for use in this investigation of test methods. The films are described in Table I.

Each roll of film was cut into 20 pieces. The pieces from the 36-in. wide film were 32 in. long, and those from the 48-in. wide film 24 in. long. Only alternate pieces were used in these tests.

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NOTE.—DISCUSSION OF THIS PAPER IS INVITED, either for publication or for the attention of the author. Address all communications to ASTM Headquarters, 1916 Race St., Philadelphia 3, Pa.

[1] 1954 Supplement to Book of ASTM Standards, Part 6, p. 420.

[2] 1952 Book of ASTM Standards, Part 6, p. 652.

TABLE I.—DESCRIPTION OF PLASTIC FILMS TESTED.

Material Designation	Nominal Thickness, in.	Width, in.	Remarks
A	0.002	36	Vinyl plastic, 20 per cent plasticized, solution cast
B	0.002	36	Vinyl plastic, 30 per cent plasticized, solution cast
C	0.004	36	Vinyl plastic
D	0.004	48	Vinyl plastic, DOP plasticized, calendered
E	0.004	36	Polyethylene

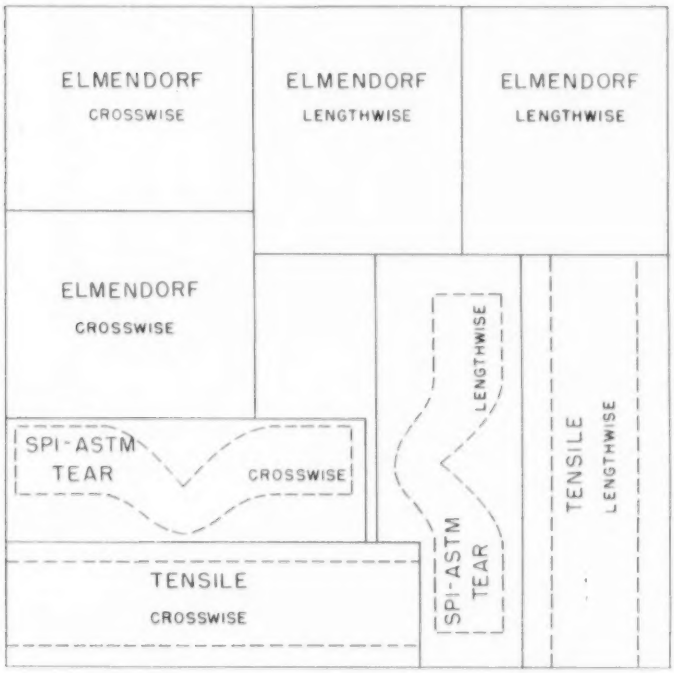

Fig. 1.—Location of Test Specimens in Specimen Blocks.

Sixteen specimen blocks, 8 by 8 in., were cut from each piece of 36-in. wide film, and fifteen from each piece of 48-in. wide film. Two inches along each edge of the 36-in. film and 4 in. along each edge of the 48-in. film were discarded.

From each piece, one block was allocated to each of the participating instruments, using a random process for the association of the blocks with the instruments. Thus, to each instrument there corresponded a "set," consisting of blocks from all ten pieces of each material. Table II lists the type of instrument and the tests that were made on each set. The test specimens were cut from the blocks by the testing laboratory in accordance with the plan shown in Fig. 1.

Methods of Test

The test specimens were conditioned at 23 C (73.5 F) and 50 per cent relative humidity for at least 48 hr prior to testing and were tested at these conditions.

Tensile Properties

The tensile strength and elongation at break were determined in accordance with ASTM Method D 882.[1] There were ten specimens for each of two directions, lengthwise and crosswise, for each set.

The tensile properties were determined on the pendulum-type machine in accordance with Method B of ASTM Method D 882. The specimens were 1 by 5 in. The initial grip separation was 2 in., the gage length was 1 in., and the rate of motion of the powered grip was 20 in. per min.

The tensile properties were determined on the inclined plane machine in accordance with Method A of ASTM Method D 882. Here the specimens were 0.5 by 5 in. The initial grip separation and the gage length were 1 in.

TABLE II.—DISTRIBUTION OF SETS OF SPECIMENS.

Set	Machine	Tests[a]
No. I	Pendulum[b]	T, S, E
No. II	Pendulum[b]	T, S, E
No. III	Pendulum[b]	T, S, E
No. IV	Static[c]	T, S
No. V	Pendulum[b]	T, S, E
No. VI	Pendulum[b]	T, E
No. VII	Pendulum[b]	T, S, E
No. VIII	Inclined plane[d]	T
No. IX	Inclined plane[d]	T, S
No. X	Static[c]	T, S
No. XI	Static[c]	T, S

[a] T = tensile strength and elongation. S = SPI-ASTM tear resistance. E = Elmendorf tearing resistance.

[b] Pendulum weighing - constant rate of powered grip motion test.

[c] Static weighing - constant rate of grip separation test.

[d] Moving weighing - constant rate of loading test.

A carriage weight of 10 lb and a rate of loading of 20,000 lb per sq in. per min based on the original area were used.

Method B was also used to determine the tensile properties on the static machine with a constant rate of grip separation of 20 in. per min. The specimens measured 1 by 5 in. An initial grip separation of 2 in. and a gage length of 1 in. were used.

SPI-ASTM Tear Resistance (Modified Graves)

The tear resistance was determined in accordance with ASTM Method D 1004.[2] This test measures the force required to start a tear in the material. Ten specimens for each of two directions, lengthwise and crosswise, were tested individually. The initial jaw separation was 2 in. For the pendulum-type machine the rate of motion of the powered grip was 20 in. per min. For the static machine with controlled separation, the rate of grip separation was 20 in. per min. A rate of loading of 2 lb per min. per 0.001 in. of thickness was used for the inclined plane machine.

Elmendorf Tearing Resistance

The Elmendorf tearing resistance was determined in accordance with ASTM Method D 689.[3] This test measures the force required to continue tearing the material after a tear is started. Twenty single specimens for each of two directions, lengthwise and crosswise, were tested. The specimens were 3.0 by 2.5 in., with the 3.0-in. dimension in the lengthwise direction for lengthwise specimens. To test the lengthwise direction, the 3.0-in. side was horizontal in the machine, thus tearing the lengthwise fibers. These lengthwise and crosswise directions are the opposite of those defined in ASTM Method D 689. Scale readings were in the range of 20 to 60; for readings above 60 an additional weight was used.

[3] Method of Test for Internal Tearing Resistance of Paper (D 689-44), 1952 Book of ASTM Standards, Part 7, p. 763.

TABLE III.—TENSILE STRENGTH OF SETS OF PLASTIC FILMS.

Type of Testing Machine	Specimen Set	Direction[a]	Tensile Strength of Material									
			A		B		C		D		E	
			Average,[b] psi	Coefficient of Variation, per cent	Average,[b] psi	Coefficient of Variation, per cent	Average,[b] psi	Coefficient of Variation, per cent	Average,[b] psi	Coefficient of Variation, per cent	Average,[b] psi	Coefficient of Variation, per cent
Pendulum	No. I	L	4060	8.4	2690	4.8	2140	9.3	2610	14.6	2060	5.8
		C	3800	11.0	2630	4.9	1970	5.1	2170	8.3	1430	8.4
	No. II	L	2890	4.5	1820	41.2	1450	8.3	1950	9.2	1390	6.5
		C	2810	6.0	1700	12.9	1310	19.1	1450	22.1	900	5.6
	No. III	L	3880	15.2	3530	12.2	2200	2.7	2610	11.5	2180	11.9
		C	4370	8.9	3310	11.5	2170	6.4	2540	9.8	1860	17.7
	No. V	L	4290	11.9	2780	14.4	1970	6.6	2660	7.1	2220	4.5
		C	4600	11.7	2810	6.0	2020	11.9	2380	11.8	1550	5.8
	No. VI	L	4140	7.0	3000	11.7	2370	10.1	3010	11.0	2200	3.2
		C	4250	4.5	3210	7.8	2400	7.5	2810	9.6	1870	4.3
	No. VII	L	4190	3.6	2850	5.6	2160	3.2	2670	6.0	1660	3.6
		C	4140	4.8	2680	3.4	2000	5.0	2310	7.4	1220	4.9
Average		L	3910	...	2780	...	2050	...	2580	...	1950	...
		C	3990	...	2720	...	1980	...	2280	...	1470	...
Inclined plane	No. VIII	L	...	...	...	...	3080	3.9	3400	9.4	2680	5.6
		C	...	...	...	...	2860	7.7	3230	11.1	2060	3.9
	No. IX	L	4890	2.0	4910	5.5	3100	2.2	3630	5.0	2420	5.8
		C	4900	2.8	4620	5.2	3060	2.9	3490	5.4	2110	1.9
Average		L	4890	...	4910	...	3090	...	3510	...	2550	...
		C	4900	...	4620	...	2960	...	3360	...	2080	...
Static	No. IV	L	4490	6.2	3200	13.4	2410	4.6	3120	2.2	2430	7.0
		C	4230	4.0	3010	13.6	2270	5.7	2600	9.2	1770	5.1
	No. X	L	3930	9.9	3380	4.1	2110	3.8	2940	10.9	2350	4.7
		C	3830	4.2	3270	3.7	2030	4.9	2730	7.0	1910	7.3
	No. XI	L	5780	4.8	4010	18.0	2470	9.7	3380	3.8	2520	16.3
		C	5530	12.1	4070	4.2	2440	3.3	3070	8.5	2300	17.0
Average		L	4730	...	3530	...	2330	...	3150	...	2430	...
		C	4530	...	3450	...	2250	...	2800	...	1990	...
All	Nos. I–XI	L	4410	...	3310	...	2330	...	2920	...	2190	...
		C	4380	...	3190	...	2250	...	2660	...	1720	...

[a] L = lengthwise. C = crosswise.
[b] The average of ten test specimens.

TABLE IV.—TENSILE ELONGATION AT BREAK OF SETS OF PLASTIC FILMS.

Type of Testing Machine	Specimen Set	Direction[a]	Elongation of Material									
			A		B		C		D		E	
			Average,[b] per cent	Coefficient of Variation, per cent	Average,[b] per cent	Coefficient of Variation, per cent	Average,[b] per cent	Coefficient of Variation, per cent	Average,[b] per cent	Coefficient of Variation, per cent	Average,[b] per cent	Coefficient of Variation, per cent
Pendulum	No. I	L	170	23.5	180	11.1	170	14.7	210	16.7	310	12.9
		C	150	30.0	190	13.2	185	5.4	260	9.6	390	38.5
	No. II	L	130	19.2	165	12.1	150	10.0	175	11.4	185	8.1
		C	165	12.1	165	12.1	200	15.0	190	18.4	245	63.3
	No. III	L	185	35.1	245	12.2	205	12.2	190	13.2	365	11.0
		C	235	6.4	250	12.0	250	6.0	270	7.4	580	23.3
	No. V	L	160	18.8	160	25.0	115	30.4	155	9.7	345	11.6
		C	170	23.5	170	11.8	170	14.7	210	14.3	470	6.4
	No. VI	L	255	3.9	285	8.8	265	17.0	320	3.1	385	11.7
		C	270	3.7	315	4.8	320	6.2	370	8.1	615	4.9
	No. VII	L	200	20.0	275	3.6	270	3.7	285	3.5	295	11.9
		C	215	9.3	280	3.6	305	4.9	320	4.7	375	30.7
Average		L	185	...	220	...	195	...	220	...	315	...
		C	200	...	230	...	240	...	270	...	445	...
Inclined plane	No. VIII	L	...	...	...	...	235	8.5	250	14.0	...	...
		C	...	...	...	...	265	9.4	320	15.6	...	...
	No. IX	L	315	22.2	385	5.2	305	4.9	325	6.2	580	7.8
		C	300	28.3	385	3.9	345	4.3	400	2.5	660	3.0
Average		L	315	...	385	...	270	...	290	...	580	...
		C	300	...	385	...	305	...	360	...	660	...
Static	No. IV	L	165	12.1	190	18.4	170	5.9	210	7.1	305	9.8
		C	155	9.7	195	10.2	195	7.7	250	6.0	485	6.2
	No. X	L	170	11.8	235	2.1	200	15.0	240	6.2	390	7.7
		C	170	5.9	250	2.0	220	6.8	310	6.4	600	7.5
	No. XI	L	245	8.2	255	21.6	170	11.8	225	8.9	385	26.0
		C	235	14.9	270	5.6	225	6.7	285	10.5	645	7.8
Average		L	195	...	225	...	180	...	225	...	360	...
		C	185	...	240	...	215	...	280	...	575	...
All	Nos. I–XI	L	200	...	240	...	205	...	235	...	355	...
		C	210	...	250	...	240	...	290	...	505	...

[a] L = lengthwise. C = crosswise.
[b] The average of ten specimens.

TABLE V.—SPI-ASTM TEAR RESISTANCE OF SETS OF PLASTIC FILMS.

Type of Testing Machine	Specimen Set	Direction[a]	SPI-ASTM Tear Resistance of Materials[b] A Average, lb per in	A Coefficient of Variation, per cent	B Average, lb per in.	B Coefficient of Variation, per cent	C Average, lb per in.	C Coefficient of Variation, per cent	D Average, lb per in.	D Coefficient of Variation, per cent	E Average, lb per in.	E Coefficient of Variation, per cent
Pendulum	No. I	L	660	13.6	180	30.6	290	5.2	315	9.5	490	6.1
		C	610	14.8	60	8.3	260	13.5	240	4.2	350	4.3
	No. II	L	535	8.4	300	13.3	250	4.0	265	9.4	360	5.6
		C	550	10.0	280	7.1	220	11.4	215	7.0	240	10.4
	No. III	L	350	17.1	140	25.0	210	4.8	250	12.0	340	5.9
		C	300	11.7	150	33.3	200	7.5	220	22.7	310	19.4
	No. V	L	690	3.6	375	4.0	310	4.8	315	3.2	475	1.0
		C	670	4.5	345	4.3	250	4.0	250	4.0	355	4.2
	No. VII	L	655	3.8	450	6.7	335	3.0	380	6.6	500	2.0
		C									385	6.5
Average		L	575	...	290	...	280		305		435	...
		C	530		210		235		230		330	
Inclined plane	No. IX	L	655	8.4	505	4.0	365	4.1	370	6.8	510	3.9
		C	645	7.0	475	5.3	330	7.6	305	4.9	425	4.7
Average		L	655	...	505	...	365	...	370	...	510	...
		C	645		475		330		305		425	
Static	No. IV	L	430	7.0	310	4.8	280	7.1	285	5.3	450	5.6
		C	420	2.4	290	3.4	240	12.5	230	17.4	310	11.3
	No. X	L	385	10.4	335	3.0	320	3.1	320	4.7	475	2.1
		C	390	12.8	335	4.5	270	5.6	255	5.9	335	6.0
	No. XI	L	690	18.1	315	3.2	290	5.2	315	6.3	465	2.2
		C	630	23.8	300	5.0	225	4.4	240	16.7	310	4.8
Average		L	500	...	320	...	295		305		465	...
		C	480		310		245		240		315	
All	Nos. I–XI except VI and VIII	L	550	...	315	...	295	...	310	...	455	...
		C	520		275		250		240		335	

[a] L = lengthwise. C = crosswise.
[b] ASTM Method D 1004. The average of ten test specimens.

TABLE VI.—ELMENDORF TEARING RESISTANCE OF PLASTIC FILMS.

Specimen Set	Direction[a]	Tearing Resistance of Material A Average,[b] g per sheet	A Coefficient of Variation, per cent	B Average,[b] g per sheet	B Coefficient of Variation, per cent	C Average,[b] g per sheet	C Coefficient of Variation, per cent	D Average,[b] g per sheet	D Coefficient of Variation, percent	E Average,[b] g per sheet	E Coefficient of Variation, per cent
No. I	L	75	26.7	590	16.1	980	37.2	865	11.6	685	8.0
	C	60	25.0	525	13.3	445	13.5	340	10.3	875	50.3
No. II	L	115	8.7	720	20.8	565	18.6	995	17.1	695	13.7
	C	110	13.6	615	7.3	235	17.0	450	8.9	825	29.7
No. III	L	95	15.8	650	6.9	995	9.5	915	12.6	790	10.1
	C	95	26.3	565	13.3	405	19.8	380	14.5	730	29.4
No. V	L	80	18.8	705	9.2	1090	17.0	990	9.6	750	10.0
	C	70	14.3	580	15.5	465	24.7	405	12.3	1215	47.7
No. VI	L	85	11.8	700	12.8	1130	15.0	1050	9.5	745	9.4
	C	80	12.5	645	17.8	515	24.9	445	7.9	1180	49.2
No. VII	L	105	57.1	720	8.3	1180	17.8	1000	28.5	765	9.2
	C	100	45.0	600	13.3	505	21.8	420	13.1	780	50.0
All	L	95		680		990		970		740	
	C	85		590		430		405		935	

[a] L = lengthwise. C = crosswise.
[b] The average obtained with 20 test specimens.
[c] Two specimens were placed together and cut in half. The four thicknesses were tested together.

Test Results

The results of the tensile strength measurements of the individual sets of specimens, as well as the average results, are given in Table III. The laboratory that tested set No. II obtained exceptionally low results for all materials in both directions; the reason for this is unknown.

The results of measurements of the tensile elongation at rupture of the individual sets of specimens are presented in Table IV, along with the averages. Unusually low results were obtained with the polyethylene film of set No. II; the reason was undetermined.

Table V presents the results and averages of the SPI-ASTM tear resistance tests on the sets of specimens.

The results of the Elmendorf tearing resistance tests are given in Table VI.

Statistical Analysis

Analyses of variance were made on the data for tensile strength, ultimate elongation, tear resistance according to the SPI-ASTM method, and tear resistance with the Elmendorf instrument. Components of variance, derived from these analyses, are listed in Table VII. The components are measures for the contributions of various factors to the total variability. They are expressed as variances because the latter, rather than the standard deviations, are additive in their effects.[4] The component for "within instrument" measures the variability of repeated measurements on the same material using the same instrument. The component for "among instruments (of the same type)" measures the additional variability introduced by consistent differences from one instrument to another of the same type. The component denoted "instrument × material" is a measure of the residual vari-

[4] The model used for analysis was as follows: measured property = (constant) + (systematic effect of material) + (systematic effect of type) + (random effect of instrument of a given type) + (systematic effect of material × type interaction) + (random effect of material × instrument interaction) + (random residual error).

TABLE VII.—COMPONENTS OF VARIANCE.

Type of Instrument	Source of Variance	Components of Variance[a]			
		Tensile Strength, psi[2]	Maximum Elongation, per cent[2]	SPI-ASTM Tear Resistance, (lb per in.)[2, b]	Elmendorf Tear Resistance, [b] (g per sheet)[2]
Pendulum	Within instrument	36 000	620	520	18.5×10^{-4}
		33 000	790	560	34.4×10^{-4}
	Among instruments	135 800	2 463	5 829	0
		208 600	3 951	1 656	0
	Instrument × material	44 400	1 145	3 643	42.8×10^{-4}
		32 700	2 724	7 645	75.9×10^{-4}
Static	Within instrument	45 000	530	340	
		34 000	360	400	
	Among instruments	100 300	518	0	
		150 800	1 347	0	
	Instrument × material	130 000	612	5 611	
		100 200	360	3 964	
Inclined plane	Within instrument	19 000	790	[c]	
		14 000	420		
	Among instruments	0	2 625	[c]	
		12 500	3 200		
	Instrument × material	28 300	0	[c]	
		4 500	0		
All types	Type × material	22 600	235	973	
		12 400	1 941	1 462	

[a] The first value in each grouping refers to the lengthwise direction; the second to the crosswise direction.
[b] On logarithms of averages of 20. See text.
[c] No analysis made because of scarcity of data.

TABLE VIII.—SYSTEMATIC DIFFERENCES AMONG TYPES OF INSTRUMENTS.[a]

Type of Instrument	Systematic Difference with Respect to Pendulum Machine		
	Tensile Strength, psi	Maximum Elongation, per cent	SPI-ASTM Tear Resistance, lb per in.
Pendulum	0	0	0
Static	+500	0	0
Inclined plane	+900	+75	[b]

[a] For convenience, the pendulum-type instruments were taken for reference points; the values in this table are approximations.
[b] Not calculated because of scarcity of data.

TABLE IX.—COEFFICIENT OF VARIATION, PER CENT (VARIABILITY OF SINGLE MEASUREMENTS).

Type of Instrument	Tensile Strength		Maximum Elongation		SPI-ASTM Tear Resistance		Elmendorf Tear Resistance	
	L[a]	C[b]	L	C	L	C	L	C
Single pendulum	6.7	6.8	10.8	9.8	6.1	7.7	9.9	13.5
Several pendulums	16.2	19.5	28.2	30.3	26.5	31.9	18.0	24.1
Single static	7.4	6.8	10.0	6.7	4.8	6.4		
Several statics	18.3	19.9	17.8	17.9	20.4	21.3		
Single inclined plane	4.9	4.5	12.1	7.0				
Several inclined planes	7.7	6.8	25.2	21.1				
Different types[c]	19.3	20.7	29.1	34.1	27.8	34.2		

[a] L = lengthwise.
[b] C = crosswise.
[c] After correction for systematic differences among instruments of different types (see Table VIII). The coefficients of variation given for this category are valid only for the materials included in this study.

ability among instruments of the same type, after corrections have been made for consistent differences among these instruments. Similarly, the component denoted "type × material" is a measure of the additional variability among instruments of different types, after corrections for systematic differences among these types have been made. The systematic differences among types of instruments are given separately in Table VIII; they are not expressed as components of variance, because they are not random variables but instead are fixed values. The consistent differences among instruments of the same type are random variables, however, since the instruments used in this study may be considered as a random selection from a population of instruments of the same type.

To show the practical significance of the results of the analysis, per cent coefficients of variation were calculated, reflecting the experimental error of single measurements for various experimental conditions. These coefficients are listed in Table IX. The experimental conditions considered are:

1. Measurements made by means of a single instrument of a given type.
2. Measurements made by means of several instruments, all of the same type.
3. Measurements made by means of several instruments, not all of the same type.

In each case, the coefficient of variation can be interpreted in the following manner: the total percentage uncertainty in a single measurement is obtained by taking twice the coefficient of variation on each side of the measured value. This range includes about 95 per cent of replicate measurements made under the same conditions.

Tensile Strength

From Tables VII and IX it appears that the precision of the inclined plane instruments is somewhat better, both within a single instrument and among instruments, than that of the other types. However, since only two inclined plane instruments were included in the study, no conclusive statement can be made in regard to their precision relative to other types of instruments.

Another point of interest is the larger variability among instruments of the pendulum type than among instruments of the static type. However, as shown by the components for "instruments × material," this advantage of the static machines is offset by the poorer ability of these instruments to reproduce the differences among materials from instrument to instrument.

Large systematic differences exist among the three types of instruments as shown in Table VIII, the pendulum results being about 500 lb per sq in. lower than those obtained by static machines, which in turn are about 400 lb per sq in. below those obtained by inclined plane instruments. After making allowances for these systematic differences, however, there is almost no more variability if types are used interchangeably than if instruments of the same type are used interchangeably.

Maximum Elongation

The values obtained by static-type instruments are more reproducible than those obtained by the other two types, both within and among instruments. From the viewpoint of the consistency of differences among materials from instrument to instrument, the inclined plane type appears superior, but any conclusions regarding the precision of this type are tentative because only two instruments are involved.

Inclined plane results are about 75 units (per cent elongation) higher than those obtained either with pendulum or static instruments. Allowing a correction for this systematic difference, the use of instruments of different types does not appreciably increase the uncertainty of results beyond that result-

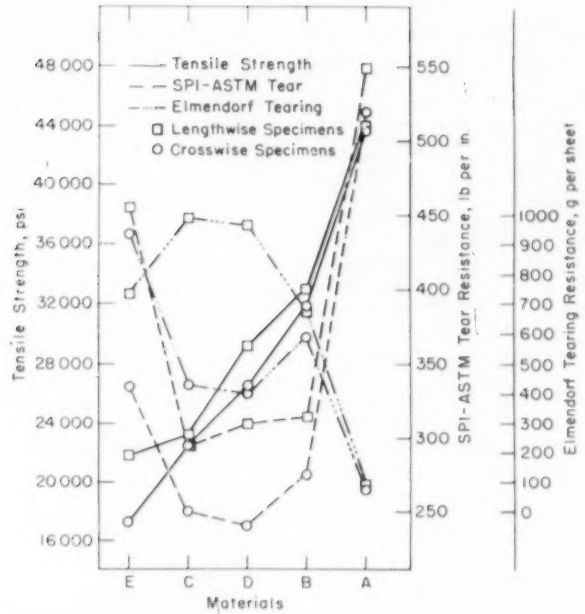

Fig. 2.—Relations Between Tensile Strength and Tear Resistance of Plastic Films.

ing from the use of several pendulum instruments.

Tear Resistance (SPI-ASTM)

Considerable variability is noted among instruments of the pendulum type, whereas the static instruments show no systematic differences. However, the differences among materials are no more consistent among static instruments than among pendulum instruments. In either case, there is considerably larger variation from instrument to instrument in the differences among materials than would be inferred from the reproducibility of replicate measurements on the same instrument.

No systematic differences were found among the results obtained by the two types of instruments, pendulum and static.

Tear Resistance (Elmendorf)

The relative spread of values in this test for the five materials is considerably greater than for the other tests, mainly because of the very low values obtained for material *A*. Consequently, a logarithmic transformation was made on the data obtained in this test, prior to analysis. The results indicate that, although no systematic differences can be detected among the six instruments included in the study, there is considerable variability in the differences (in this case, ratios) among materials from instrument to instrument. Consequently, the use of several instruments increases the experimental error appreciably, despite the absence of systematic differences among instruments.

Discussion

There are some detailed points of interest in addition to the more general results revealed by the statistical analysis.

Tear Resistance

The tear resistance in the lengthwise direction is higher or essentially the same as that in the crosswise direction for all the vinyl plastics in both tests. The SPI-ASTM test gives higher results for the lengthwise direction of the polyethylene film, whereas the converse is true for the Elmendorf test. The greatest differences in lengthwise and crosswise tear resistance in the Elmendorf test are observed with materials *C* and *D* where the ratio is about 2:1; this property was one of the reasons for selecting these two materials for the tests. The values for the tearing resistance of the polyethylene film in the Elmendorf tests varied greatly in the crosswise direction.

Relation Between Tensile and Tear Properties

The tensile strength and tear resistance values for the various materials are plotted in Fig. 2. The average tensile strength values for the various machines and similar values for the SPI-ASTM tear resistance are used in these plots, since there is no appreciable interaction among machines and materials as shown by the statistical analysis of the results. These curves do not indicate that there is any relation between tensile strength and tear resistance, either SPI-ASTM or Elmendorf,

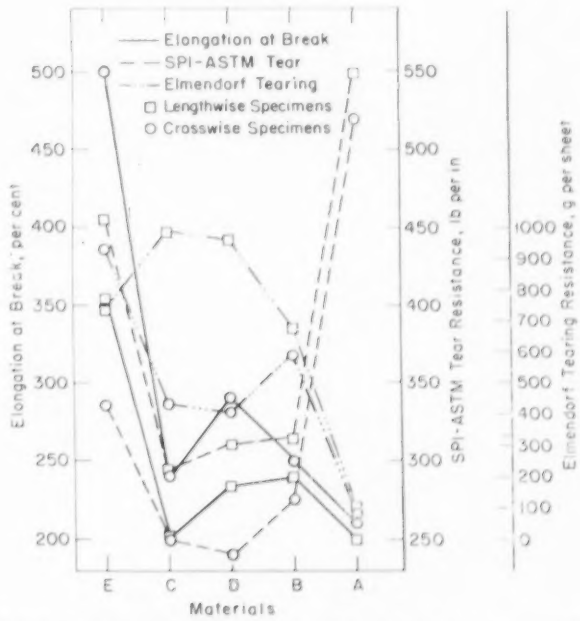

Fig. 3.—Relations Between Elongation at Break and Tear Resistance of Plastic Films.

for the group of films tested. Although it may be possible for control purposes to use tensile strength instead of the SPI-ASTM tear resistance for checking batches of one type of plastic film, it is quite evident that this procedure cannot be applied to all types of plastic films or to various formulations of vinyl plastic films.

The tensile elongation and tear resistance values for the various materials are plotted in Fig. 3. The results show no relationship between tensile elongation and tear resistance, either SPI-ASTM or Elmendorf, for the group of films tested.

The relation between SPI-ASTM tear resistance and Elmendorf tearing resistance values for the various materials can be seen from the curves in Fig. 2. The results show that there is no relation between these two measurements of tear resistance for the group of films tested. Since the SPI-ASTM tear resistance has a high tensile component that is required to start a tear and the Elmendorf tearing resistance is the shearing force required to continue a tear, the lack of relation between the two for a group of films, even of the same plastic type, is easily understandable.

Effects of Variation in Test Methods on Results

It is evident from an examination of Table III that the three methods and machines used to measure tensile strength cannot be used interchangeably in specifications for plastic films unless different requirements are set for each method and machine. For example, the inclined plane and the static machines might be used interchangeably in a specification for materials *A* and *E*, but they could not be used in one for materials *B*, *C*, and *D*. The pendulum machine could not be used interchangeably for either of the other two machines; the results obtained with the pendulum machines were significantly lower in every case.

The values for tensile elongation at rupture (Table IV) obtained by the three machines do not vary nearly so much as they do for the tensile strength. It appears that the pendulum and static machines could be used interchangeably in specifications to determine the elongation at rupture of plastic films. The results obtained with the inclined plane machine were significantly higher than those obtained by the other machines.

The data in Table V indicate that it may be possible to use the pendulum and the static machines interchangeably in specifications to determine the SPI-ASTM tear resistance of plastic films, but the inclined plane machine gives significantly higher results.

Reproducibility Among Laboratories

The results indicate that better reproducibility will be obtained among laboratories in the measurement of tensile elongation at rupture and SPI-ASTM tear resistance by using static machines than by using pendulum machines.

The agreement among the results obtained with the various Elmendorf machines is poor, particularly with respect to the differences among materials.

Limitations in Using Test Methods

The results observed in the various laboratories indicate that the inclined plane machine cannot always be used to determine the tensile strength and elongation at rupture of polyethylene films. One laboratory could not use the inclined plane machine on two of the vinyl plastic materials to determine these properties. Another laboratory could not use the pendulum machine to determine the SPI-ASTM tear resistance of all four vinyl plastic films in the crosswise direction. The inability to use the machines to make these tests is attributed to two factors: (1) in some cases the machine is not able to maintain the specified rate of motion because of the rapid rate of extensibility of the film; (2) in other cases the total extension of the machine is not sufficient to rupture the specimen.

The initial jaw separation in the SPI-ASTM tear resistance tests was 2 in. instead of 1 in. as recommended in ASTM Method D 1004. This increase to 2 in. makes it less difficult to place and align the specimen in the grips.

Conclusions

The conclusions drawn from the results of these round-robin tests with the selected plastic films are as follows:

1. Tensile strength, SPI-ASTM tear resistance, and Elmendorf tear resistance of plastic films are measurements of three different properties or combinations of properties, and one cannot be used in place of another.

2. The results presented showed that revisions of ASTM Methods D 882 and D 1004 were needed. Method D 882 has been revised, and a revision of Method D 1004 is under way. Some factors that are not specified at present need consideration so that reproducible results can be obtained.

3. Reasonable specification requirements for tensile strength, tensile elongation, and SPI-ASTM tear resistance cannot be established to permit the interchangeable use of the three types of machines investigated in this study. A different requirement value for each property for each machine would have to be established.

The Bookshelf

Aluminum Paint and Powder

J. D. Edwards and R. I. Wray, Reinhold Publishing Corp. New York, N. Y., 211 pp.

A third edition of this very able volume by two competent authorities, brings the story of aluminum paint and powder quite up to date. The well known and respected Robert I. Wray joins the senior author, Junius D. Edwards, for this venture. It is a particularly honest treatment, conservative in its statements, intended for consumption by technicians, not laymen. Format, printing and binding are highgrade. Each chapter is replete with references and documentation, so the work constitutes a real "overhauling" of a rather limited or concentrated field. An adequate amount of solid data peppers the book, with ample support drawn from outside authorities. This is particularly true of the chapters concerning the application of aluminum coatings to metal. Throughout, the frequent use of pictures and photomicrographs help the lucid explanatory material.

A brief sketching of chapter headings is necessary to an understanding of the scope of the study:

1—Manufacture of Aluminum Powder
2—Properties and Testing
3—Composition of Aluminum Paint (formulas)
4—Protection of Metals (with Aluminum paint)
5—Reflectance, Visibility, Special Applications
6—Protection of Wood
7—Use of Aluminum powder in printing, rubber, plastics, powder metallurgy, paper, textiles, etc.

What few criticisms come to mind are of a minor nature, perhaps merely reflecting the personal interests of the reviewer: Some condensation, terseness of statement and careful scrutiny for repetition might produce slight improvement. Opportunity to tie "end to end" an interesting historical sketch of the introduction and growth of aluminum powder and its applications is overlooked, perhaps because it was considered unimportant. The volume has a highly desirable "up-to-dateness" including the properties and uses of aluminum coatings made from silicone and synthetic rubber resins, but one looks in vain for any guidance as to epoxy-aluminum coatings. The sections concerning polychrome and hammered metal finishes are disappointingly brief for a paint man.

This volume is unique in that it stands alone as a connected, related account of aluminum powder technology in this country. Only in the literature of manufacturers of aluminum powder can one obtain comparable data, and that piecemeal. It is hard to see how a useful and reasonably complete technical library in the coatings field can afford to be without this volume.

E. J. Lewis

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Emulsion Polymerization

F. A. Bovey, I. M. Kolthoff, A. I. Medalia, and E. J. Meehan, Interscience Publishers, 250 Fifth Ave., New York 1, N. Y., 445 pp., $12.50.

To the average citizen, rubber is simply a material with more bounce to the ounce than anything else in the world. He uses it with calm assurance that it will carry him safely over high-speed highways, keep his feet dry when it rains, or do a million other jobs in a dependable and efficient manner. To the man of science, rubber represents a dramatic super-production which opens with a presentation of one of Nature's innumerable mysteries—the formation of rubber in the living plant. Lacking some of the mystery, but equally fascinating is the remainder of the production depicting man's amazing success in developing a fine synthetic product—an intriguing tale in which the principal parts are played by brains, sweat, and Government money.

This book covers an important phase in the whole process which starts with crude oil and coal tar and ends with an automobile tire or other useful article. It is called emulsion polymerization and constitutes a principal mechanism in converting basic ingredients in the liquid form to the usable solids which later become synthetic rubber.

The book is written by rubber researchers for men and women of the same persuasion. Nevertheless, it would be difficult to imagine anyone in the field of polymer chemistry who could read it without profit. There are nine subject chapters presented in logical sequence: Historical Background and General Considerations, Nature of Free Radical Polymerization, Initiating Systems, Chain-Transfer Agents, Role of Detergent, Kinetics, Inhibition and Retardation, Copolymerization, Experimental Methods, Standard GR-S Recipe, and Activated Recipes. Although continuity is adequate, each chapter can stand alone as a scholarly presentation of its subject and can serve as source material covering the most authoritative thinking in the intricate realm of molecular structure.

As one would expect from the authorship, the work is mature and objective. Its freedom from a know-it-all attitude is evidenced by comprehensive referring to outstanding authorities in the high polymer field. The writing is in the relaxed style of those who know their subject.

"Emulsion Polymerization" is a worthy addition to the Interscience Publishers, Inc., series on High Polymers and is recommended reading for all those who seek more knowledge in an area of chemistry so vitally important to our national economy and security.

Robert Burns

• • •

Vapor Plating

C. F. Powell, I. E. Campbell, and B. W. Gonser, John Wiley & Sons, Inc., New York, N. Y., $5.50.

This book is primarily a bibliography, although considerable information is included which is apparently based on the personal experience of the authors. The organization is excellent, and the phase of the subject that is treated is very thoroughly covered. The title does not suggest that only the chemical processes are dealt with to the exclusion of the physical processes. In their preface, however, the authors distinguish between the two and clearly state that the book pertains only to chemical processes. One might raise the question whether the comment in the introduction that most of the attempts to electrodeposit titanium, tantalum, molybdenum, tungsten, and other metals have been unsuccessful, does full justice to some of the work in the field of electrodeposition from fused salts.[1]

The photomicrographs given are quite informative; in fact additional photomicrographs might well enhance the value of the book, particularly if they were dispersed throughout the book at appropriate locations instead of being confined to the introduction.

The list of references on the chemical processes of vapor plating appears to be indeed exhaustive. The references are in fact so numerous that a further service would have been done the reader by some evaluation of them, such as a separate list or special notation to indicate references of exceptional value.

Separate chapters cover the subjects: Metals, Carbides, Nitrides, Boron and Borides, Silicons and Silicides, and Oxides. These chapters contain data pertaining to the specific compositions deposited.

This is a book which merits the attention of everyone interested in the field of vapor plating.

W. N. Harrison

[1] Senderoff and Brenner, *Journal*, Electrochemical Soc., Vol. 101, p. 16 (1954).
J. A. M. Van Liempt, *Zeitschrift Anorg. Chem.*, Vol. 122, p. 175, 1922, and Vol. 143, p. 285, 1925.

(Continued on page 71)

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PERSONALS...

News items concerning the activities of our members will be welcomed for inclusion in this column

NOTE—These "Personals" are arranged in order of alphabetical sequence of the names. Frequently two or more members may be referred to in the same note, in which case the first one named is used as a key letter. It is believed that this arrangement will facilitate reference to the news about members.

William R. Alexander was appointed Director of Engineering, The Steel Products Engineering Co., Springfield, Ohio. Formerly Assistant Director, he replaces **Delmond L. Getz,** resigned.

Max I. Beard, formerly Plant Metallurgist, The Oliver Corp., South Bend, Ind., is now Senior Engineer, Westinghouse Electric Corp., Atomic Power Div., Pittsburgh, Pa.

Rafael Beermann has accepted a position as Municipal and Sanitary Engineer, F. A. Pease Engineering Co., Shaker Heights, Ohio. He was previously associated with the Wellman Engineering Co., Cleveland, Ohio.

A. K. Brill has retired as Development Manager, Republic Rubber Div., Lee Rubber & Tire Corp., Youngstown, Ohio. He now resides at 345 19th St., Santa Monica, Calif.

Patrick E. Cavanagh, formerly with the Non-Destructive Testing Corp. (Canada), Ltd., Toronto, is now Director, Department of Engineering and Metallurgy, Ontario Research Foundation, in the same city.

Ting Ye Chu, for some time Assistant Professor of Civil Engineering, Iowa State College, Ames, has accepted appointment as Associate Professor, Civil Engineering, New York University, New York City.

Following retirement in July from the Bureau of Mines, **Arno C. Fieldner** and four fellow employees were honored by their associates with a dinner attended by 242 on August 23 in the Continental Room of the Sheraton-Park Hotel, Washington, D. C. Each honoree was presented with a suitably engraved sterling silver 15-in. tray, and there were specially selected personal gifts. Dr. Fieldner received a brief case, portable typewriter, and a desk and blotter pad. (See September, 1955, BULLETIN Personals column for item on Dr. Fieldner's retirement and ASTM activities.)

F. W. Gilcreas retired as Assistant Director of the Laboratories of Sanitary and Analytical Chemistry, New York State Department of Health, to accept an appointment as Professor of Sanitary Science at the College of Engineering, University of Florida, Gainesville.

William A. Goodwin, formerly Soils Engineer, Hazelet & Erdal, Consulting Engineers, Louisville, Ky., is now Associate Research Engineer, Tennessee Highway Research Program, University of Tennessee, Knoxville.

Robert L. Grun has been given a new assignment in the recently-formed Chemical Department of the Gulf Oil Corp., Pittsburgh, Pa. He will assist in sales and market development for the company's expanding chemical business. He has been associated with Gulf since 1936, serving in various capacities, most recently as Product Technologist in the Product Application Section of the company.

(Continued on page 63)

TESTING

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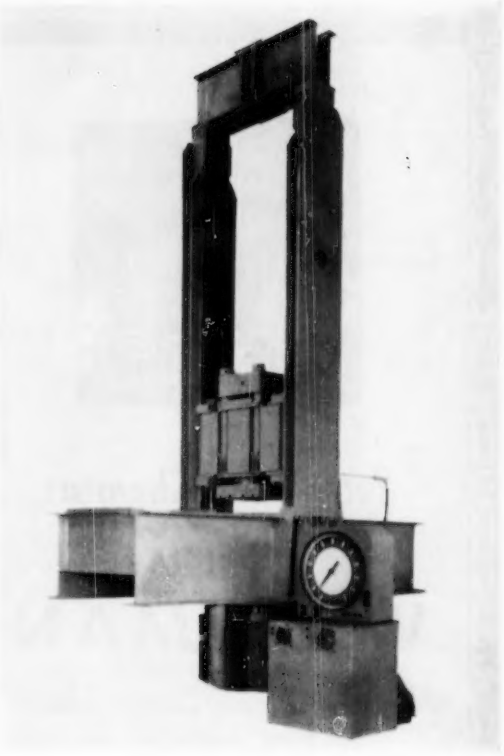

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Paper Processor, Film Processor—	Young Processors automatically develop and dry up to 12″ wide oscillograph paper—with built-in leader. Young Film Processor for developing and drying 16-35-70 mm—fully automatic. Price $2970.
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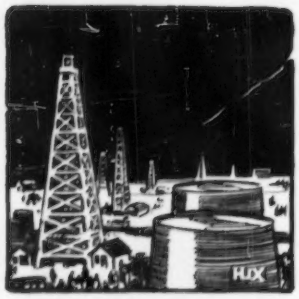

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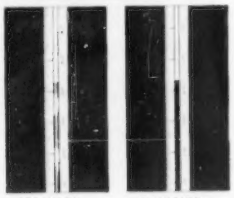

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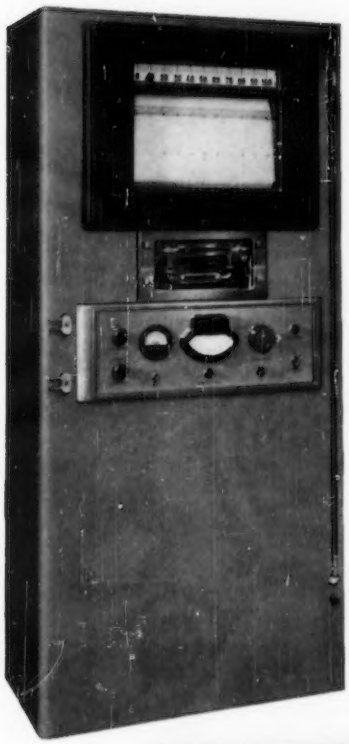

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Personals

(Continued from page 60)

Clark C. Heritage recently retired as Director of Development, Weyerhaeuser Timber Co., Tacoma, Wash. Representative of the company's Sustaining Membership in the Society, Mr. Heritage has served for many years on a number of the technical committees including those concerned with wood, paper, adhesives, and petroleum. He plans to continue his ASTM interest through personal membership. He has established his own office in Tacoma to serve industry in the field of management of research and development, specializing in the organization of the development function and its "integration into the business as an essential member of the basic triumvirate of Sales-Production-Development." Mr. Heritage has accepted an invitation from the School of Forestry of Yale University to serve as one of the leaders for their Second Industrial Forestry Seminar in November on the subject of "integration and research in the forest industries."

Hudson W. Kellogg, until recently Testing Coordinator, has been appointed Manager, Gasoline Testing Div., Ethyl Corp., New York City. He will supervise five gasoline testing operations at Ethyl's laboratories located in Yonkers, N. Y.; Baton Rouge, La.; Tulsa, Okla.; Kansas City, Mo.; and San Bernardino, Calif.

H. I. King has accepted a position as Manager, Precast Div., Siporex, Ltd., Toronto, Canada. He was previously on the engineering staff of The Cooksville Co., Ltd., in the same city.

Joseph S. Laird has retired as Chemist, Ford Motor Co., Dearborn, Mich. He plans to continue his ASTM membership and participation in the activities of Committee B-7 on Light Metals and Alloys. Mr. Laird has opened his own office as Consultant at 4225 Beechmont St., Dearborn.

Luther D. Lawrence has accepted a position with North American Aviation, Inc., Aero-physics Standards Div., Downey, Calif. He was formerly with Clarostat Manufacturing Co., Inc., Dover, N. H.

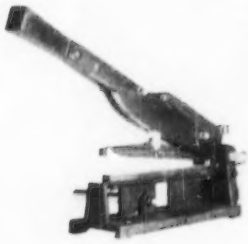
John A. MacLeod, until recently Mechanical Engineer, Bechtel Corp., San Francisco, Calif., is now Power Engineer, United Engineers and Constructors, Inc., Philadelphia, Pa.

Frank M. Masters, partner in the consulting firm, Modjeski & Masters, Harrisburg, Pa., received an honorary degree of Doctor of Engineering from Lehigh University. Mr. Masters was praised for his contributions in the field of bridge engineering, his work on American and European projects, and his valuable research on the performance of structural materials.

(Continued on page 64)

THWING-ALBERT PRECISION SAMPLE CUTTERS

The Ultimate in Precision Sample Cutting



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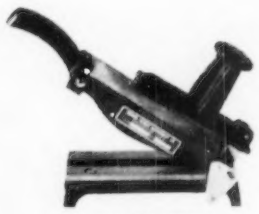

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Personals

(Continued from page 63)

Nathan M. Newmark, Research Professor of Structural Engineering, University of Illinois, received an honorary degree of Doctor of Science from Rutgers University. A 1930 graduate from Rutgers, Dr. Newmark has been a member of the Scientific Advisory Board of the Army Air Force since 1945.

R. E. Penrod has retired as Chief Metallurgist, Bethlehem Steel Co., Johnstown, Pa. He is succeeded by **E. H. Hollenback,** formerly Assistant Chief Metallurgist. Mr. Penrod plans to continue his ASTM affiliation and participation in certain technical committee activities.

Ethel L. Phelps, formerly Professor of Textiles and Clothing, Division of Home Economics, University of Minnesota, St. Paul, is now on the faculty of the University of California, Department of Home Economics, Berkeley, Calif.

Robert G. Picard has joined Central Scientific Co., Chicago, Ill., as Director of Research and Engineering Development, succeeding **Harris M. Sullivan,** now with General Electric Co.

Arthur H. Quigley recently retired from American Brass Co., subsidiary of Anaconda Co., New York City, after more than 53 years of service.

Lewis S. Reid, formerly Administrative Assistant, is now General Purchasing Agent, Metropolitan Life Insurance Co., New York City. A longtime member of the Society, Mr. Reid has served through the years on many of the technical committees. He has been especially active in Committee D-6 on Paper and Paper Products, where he was a charter member, the first secretary (for three years), and chairman for an eight-year period. He represents ASTM on the ASA Sectional Committee on Office Standards; served for six years on the ASTM Administrative Committee on Papers and Publications; and currently is a member of the Society's Administrative Committee on Standards.

Edward A. Reynolds, until recently with Ronson Art Metal Works, Newark, N. J., is now Superintendent, Quality Control, Westinghouse Electric Co., Atomic Power Div., Pittsburgh, Pa.

Le Roy Rogers has accepted a position with Kaiser Steel Corp., Napa, Calif. He was formerly Electroplating Foreman, Slick Airways, Inc., San Antonio, Tex.

Julius C. Scharmer is now Works Manager, Mall Tool Co., Chicago, Ill. He was previously with Motor Products Corp., Deep-Freeze Appliance Div., Libertyville, Ill.

Raymond B. Seymour, former President of Atlas Mineral Products Co., Mertztown, Pa., has been named President of Loven Chemical Co., Newhall, Calif.

John H. Skinkle has resigned as Executive Director, Lowell Technological Institute Research Foundation. **Dorrance H. Goodwin** has assumed the principal administrative responsibilities of the Foundation and will retain his present title of Director of Research Services. Professor Skinkle will continue his teaching duties as a full-time faculty member at the Institute (he had maintained both the teaching and administrative work for over a year) including supervision of master's degree thesis work in the Division of Chemistry.

Philip Sporn, President, American Gas & Electric Co., New York City, has been elected a Vice-President of the American Nuclear Society. This newly formed organization has 850 members.

K. G. Stoffer has resigned as Senior Chemist, The Babcock & Wilcox Co., Research Center, Alliance, Ohio, to accept a position as Chemist with the Arabian American Oil Co., in Dhahran, Saudi Arabia. He plans to continue his ASTM membership.

Ferruh Taskin, of Melzeme Laboratuari, Teknik Universite, Istanbul, Turkey, is now at the National Research Council of

(Continued on page 66)

THE ORIGINAL...

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Personals

(*Continued from page 64*)

Canada, Division of Building Research, on a Postdoctorate Fellowship.

T. Smith Taylor, longtime active member of the Society, is now associated with the New York Testing Laboratories, Inc., New York City, as Director of Research.

F. C. Tuemmler, Head, Analytical Standardization Dept., Shell Development Co., Research Center, Emeryville, Calif., was recently accorded international recognition and honor when he was elected Secretary of the Analytical Section of the International Union of Pure and Applied Chemistry in Zurich, Switzerland. He will serve during the period from 1955 to 1959. Dr. Tuemmler, who is the designate of Shell Development Co.'s Sustaining Membership, has been associated with ASTM since 1938 and has been active in many of the technical groups, his interest being concentrated chiefly in Committee D-2 on Petroleum Products and Lubricants. He was recipient of a 1952 ASTM Award of Merit, recognizing significant and valued service in the work of this group. The International Union, founded in 1918, is a voluntary organization whose chief purpose is to establish and promote cooperation among the chemical societies of the world. It has been active in the standardization of organic and inorganic nomenclature, in standardizing the table of atomic weights and other fundamental constants, and in establishing uniform conventions for designating liquid cell potential.

Roy F. Weston has resigned as Sanitary Engineer of Atlantic Refining Co. to devote full time to his consulting firm, Weston, Eckenfelder, and Associates.

Porter R. Wray was appointed Assistant Chief Metallurgical Engineer, United States Steel Corp., Pittsburgh, Pa. **A. W. MacLaren** was made Metallurgical Engineer—Alloy Steels, and **J. R. Hamilton** Assistant Metallurgical Engineer—Structural, Plate and High Strength Steels. Mr. MacLaren succeeds Mr. Wray, and Mr. Hamilton fills the position vacated by the late C. E. Loos.

DEATHS...

David Crampton, Wallace & Tiernan Co., Belleville, N. J., met sudden death August, 1955, by drowning. Mr. Crampton had served since 1947 on Committee A-5 on Corrosion of Iron and Steel and on its Subcommittee VII on Methods of Testing as representative of the American Society of Refrigerating Engineers.

Herbert J. French, Vice-President, The International Nickel Co., Inc., New York City (August 17, 1955). Representative of the International Nickel Co. Sustaining Membership for many years; personal member of the Society since 1938, and an active participant in technical committee work since 1929. Perhaps his outstanding contribution to the Society was as chairman for many years of the Joint ASTM—ASME Committee on Effect of Temperature on the Properties of Metals. His other technical interests included Committees A-1 on Steel, and B-4 on Metals for Electrical Heating, Electrical Resistance, and Electronic Applications. Outstanding in the field of physical metallurgy of ferrous and non-ferrous alloys and metals, Mr. French was Metallurgical Inspector, Bureau of Aircraft Production, U. S. Army, during World War I. From 1919 to 1929 he was Assistant Chief, Division of Metallurgy, U. S. Bureau of Standards; and for the past 25 years had been associated with the International Nickel Co. Active in many technical and professional groups, he was the 1931 Henry Marion Howe Medalist, American Society for Steel Treating; the 1933 Edward deMille Campbell Memorial Lecturer, American Society for Metals; and recipient of the 1940 Lincoln Gold Medal Award of the American Welding Society.

(*Continued on page 69*)

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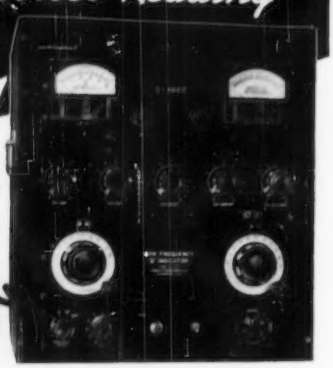

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FEATURES

- Direct reading
- Unaffected by line voltage variations
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A—Precision Tool

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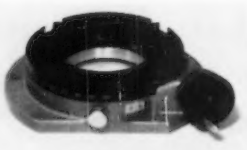
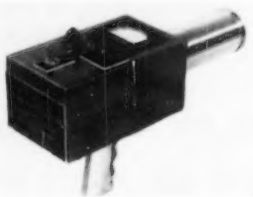


B—Cement

The CSI Long Life Sieve is recommended for routine hourly sieve analysis of cement to reduce testing costs. (ASTM Designation C 115 - 53).

C—Static

The Electrostatic Voltmeter was developed by the Institute of Textile Technology to detect and measure electrostatic charges on moving or stationary equipment or materials.



D—Abrasion

The CSI Surface Abrader is a redesign of the Universal Wear Tester for surface abrasion only. (ASTM Designation D 1175 - 55 T and D 1375 - 55 T).

E—Cotton

The Nep Test Machine was designed by the United States Department of Agriculture to provide a rapid and satisfactory method of preparing specimens of raw cotton for nep evaluation. (ASTM Designation D 1446 - 53 T).

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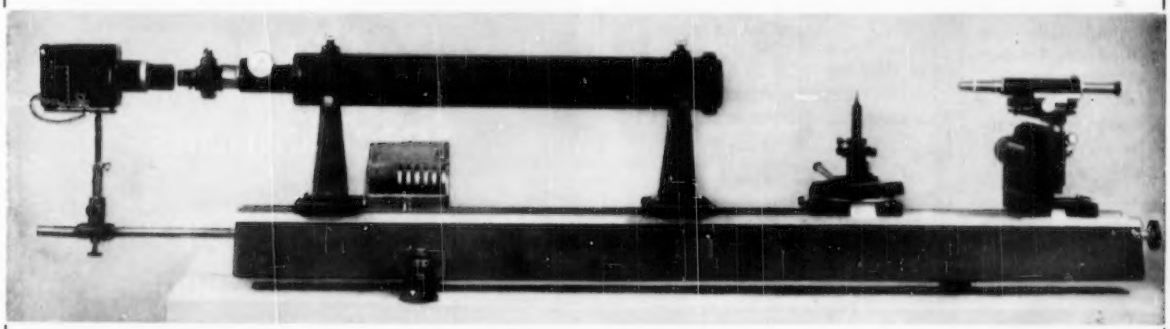

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Deaths

(Continued from page 66)

P. C. Rogers, President and Treasurer, Quincy Steel Casting Co., Wollaston, Mass. (March 18, 1955). Member since 1936.

Haakon Styri, retired Director, Research Laboratories, SKF Industries, Philadelphia, Pa., died September 13, 1955, at the age of 69. Member of Society since 1920, and a member for many years of Committees B-5 on Copper and Copper Alloys, Cast and Wrought, and E-4 on Metallography. Prior to his technical education Dr. Styri was a lieutenant in the Norwegian Coast Artillery. Upon his graduation from the Kristiania Techniske Skole in Norway he won the first American Scandinavian Foundation scholarship to Carnegie Institute of Technology, where he completed a special chemical course. Later he received his doctorate in engineering at Konigliche Technische Hochschule, Aachen, Germany. Returning to this country he took a metallurgical post at Hussey-Binns Steel Co., Charleroi, Pa.; was a member of the faculty at Carnegie Institute for a brief period, and associated with SKF Industries from 1927 until his retirement in 1951.

F. F. Vaughn, Caterpiller Tractor Co., Peoria, Ill. (August 5, 1955). Representative of company since 1949 on Committee A-3 on Cast Iron and on its Subcommittee XVIII on Automotive Castings.

NEW MEMBERS.....

The following 58 members were elected from August 18 to September 16, 1955, making the total membership 8034. Welcome to ASTM

Note—Names are arranged alphabetically—company members first, then individuals. Your ASTM Yearbook shows the areas covered by the respective Districts.

CHICAGO DISTRICT

Flood and Co., Walter H., James G. Flood, Partner, 6102 S. Blackstone Ave., Chicago 37, Ill.

Modjeska, R. Scott, Director, Scientific Control Laboratories, 600 Blue Island Ave., Chicago 7, Ill.

Wausau, City of, Engineering Department, City Hall, Wausau, Wis.

CLEVELAND DISTRICT

Goodrich-Gulf Chemicals, Inc., P. W. Cornell, Vice-President in Charge of Engineering, Operations and Research, 5317 Chester Ave., Cleveland 3, Ohio.

Dubs, Glenn T., General Manager, Canton Pattern and Manufacturing Co., Box 151, Canton 1, Ohio.

Rigo, Jane H. M., Research Chemist, American Steel and Wire Division, United States Steel Corp., Rockefeller Bldg., Cleveland 13, Ohio. For mail: 1852 E. 101st St., #2, Cleveland 6, Ohio.

DETROIT DISTRICT

Argus Cameras, Inc., Frank E. Ammermann, Chief Product Control Engineer, 405 4th St., Ann Arbor, Mich.

Wood, John, Co., Bennett Pump Division, David S. Willson, Engineering Laboratory Manager, Broadway and Wood St., Muskegon, Mich.

Covert, Richard W., President, Plastic Products Co., 6475 Georgia, Detroit 11, Mich.

NEW ENGLAND DISTRICT

Richards, W. J., Jr., Vice-President and Treasurer, Quincy Steel Casting Co., 30 Fayette St., North Quincy 71, Mass.

Sapega, August E., Assistant Professor, Trinity College, Hartford 6, Conn.

White, W. Craig, Chief, Materials Evaluation Office, Quartermasters Research and Development Center, Chemicals and Plastics Div., U. S. Department of the Army, Natick, Mass.

NEW YORK DISTRICT

Petro-Chem Development Co., Inc., J. W. Throckmorton, Vice-President, 122 E. 42nd St., New York 17, N. Y.

United Mineral and Chemical Corp., Irwin Stelzer, Sales Engineer, 16 Hudson St., New York 13, N. Y.

Dobrovich, Andrew L., Jr., Chief Inspector, W. S. Rockwell Co., 200 Eliot St., Fairfield, Conn.

Goldstein, Abraham, Chemical Engineer, Naval Air Rocket Test Station, U. S. Department of the Navy, Dover, N. J. For mail: 54 W. 175th St., Bronx 53, N. Y. [J]*

Johnson, Carroll Drum, President, Johnson Soils Engineering Laboratory, 193 West Shore Ave., Bogota, N. J.

Reynolds, Edward E., Metallurgist, Research Dept., Allegheny Ludlum Steel Corp., Watervliet, N. Y.

(Continued on page 70)

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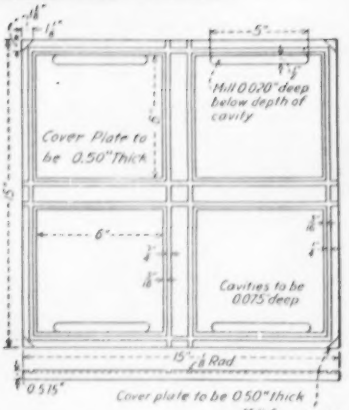
Mill 0.020" deep below depth of cavity
Cover Plate to be 0.50" Thick
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New Members

(*Continued from page 69*)

Murray, Maurice A., Chief Ceramic Engineer, The B G Corp., 321 Broad Ave., Ridgefield, N. J.

Schultz, Herbert G., Technical Assistant to Vice-President, Cities Service Research and Development Co., 60 Wall Tower, New York 5, N. Y.

Seaman, Ernest M., Chief Chemist, The Federal Leather Co., 681 Main St., Belleville, 9, N. J.

OHIO VALLEY DISTRICT

Heyer, Robert H., Supervising Metallurgist, Research Lab., Armco Steel Corp., Middletown, Ohio. For mail: 103 Kenwood Dr., Middletown 16, Ohio.

PHILADELPHIA DISTRICT

Manufacturers Engineering and Equipment Corp., Gustav Bergson, President, York Rd. and Sunset Lane, Hatboro, Pa.

Cohn, Charles C., Research Director, and Partner Colonial Alloys Co., Ridge Ave. and Crawford St., Philadelphia 29, Pa.

Jones, A. F., Directing Engineer, The General State Authority, 18th and Herr Sts., Harrisburg, Pa.

Moyer, Edward H., Owner, 3207 Kensington Ave., Philadelphia 34, Pa.

Mulligan, Robert J., Chief Rubber Chemist, American Meter Co., 1513 Race St., Philadelphia 2, Pa. For mail: 60 Great Oak Rd., Levittown, Pa.

Pschorr, Frank E., Assistant Technical Manager, Ciba Co., Inc., Kimberton, Pa.

Reid, William Charles, Sales Manager, Tester Div., Forney's Inc., Box 310, New Castle, Pa.

Ziegler, George W., Jr., Administrator, Aircraft-Marine Products, Inc., Special Projects Laboratory, 25 Alexander Ave., Carlisle, Pa.

PITTSBURGH DISTRICT

Hogan, John F., Jr., Research Assistant, Coal Chemicals Fellowship, Mellon Institute of Industrial Research, 4400 5th Ave., Pittsburgh, Pa. [J]

ST. LOUIS DISTRICT

Mann, Robert E., Partner, Mann and Co., 201 E. First, Box 1148, Hutchinson, Kans.

Smith, Rollin J., Engineer-Manager, Asphalt Dept., Skelly Oil Co., Box 436, Kansas City 41, Mo.

SOUTHERN CALIFORNIA DISTRICT

Warner, James K., Manager, Quality Control Dept., Narmco Resins and Coatings Co., 600 Victoria, Costa Mesa, Calif.

SOUTHWEST DISTRICT

McLerran, A. R., Chief Development Engineer, IDECO Div., Dresser Equipment Co., Box 3350, Beaumont, Tex.

Picard, D. S., Jr., Chief Engineer, Dallas Tank Co., Inc., Box 5387, Dallas 2, Tex.

WASHINGTON (D. C.) DISTRICT

Arni, Howard T., Materials Engineer, Concreting Materials Section, National Bureau of Standards, Connecticut Ave. and Van Ness St., N. W., Washington 25, D. C.

Irwin, Lafayette K., Mechanical Engineer, National Bureau of Standards, Connecticut Ave., and Van Ness St., N. W., Washington 25, D. C.

Schriesheim, Alan, Chemist, National Bureau of Standards, Connecticut Ave. and Van Ness St., N. W., Washington 25, D. C.

WESTERN NEW YORK—ONTARIO DISTRICT

Tefft, William L., Product Engineering, Linde Air Products Co., Division of Union Carbide and Carbon Corp., Box 44, Tonawanda, N. Y.

Toronto Library, University of, Chief Librarian, Toronto 5, Ont., Canada.

UNITED STATES AND POSSESSIONS

Bellows, K. C., President and General Manager, Western Concrete Products, Inc., 1300 Main Ave., Bismarck, N. Dak. For mail: Box 1161, Bismarck, N. Dak.

Britt, Duncan E., Jr., Partner, D. E. Britt Associates, 309 S. E. 9th Ave., Fort Lauderdale, Fla.

Dade County Planning, Zoning and Building Department, Glenn C. Smith, Deputy Director of Building, 1403 Court House, Miami, Fla.

Ewart, G. Yuan, Director, Agricultural Control and Research, Kekaha Sugar Co., Ltd., Kekaha, Kauai, Hawaii.

Hanson, Raymond G., Jr., Assistant Editor, *Design News*, Rogers Publishing Co., 3375 S. Bannock St., Englewood, Colo.

Li, Shu-t'ien, Chief Technical Writer, Palmer & Baker, Inc., 957 Spring Hill Ave., Mobile, Ala. For mail: 711 Creighton Towers, 758 St. Michael St., Mobile, Ala.

Macdonald, James, Jr., Textile Engineer, E-Z Mills, Inc., Cartersville, Ga.

Rich, Charles E., Manufacturing Manager, Sperry Electronic Tube Division of The Sperry Corp., Gainesville, Fla.

OTHER THAN U. S. POSSESSIONS

Cement and Concrete Association of Australia, T. J. Cavanagh, Director, 14 Spring St., Sidney, Australia.

Abdó Herrera, Juan, Chemical Engineer, Conductores Eléctricos, S. A., Poniente 140 y Norte 59, Col. Ind. Vallejo, 16 Mexico.

(*Continued on page 71*)

(Continued from page 70)

Attwooll, Alan W., Assistant Technical Director, The Limmer and Trinidad Lake Asphalt Co., Ltd., Steel House, Tothill St., London SW1, England.

Breckon, Clifford, Director, The Yorkshire Copper Works, Ltd., Leeds, England.

Díaz, Pedro N., Manager, Moviterra, Centro Professional del Este, Caracas, Venezuela. For mail: Apartado No. 2977, Caracas, Venezuela.

de Mello, Victor F. B., Director of Works, Geotecnica S.A., Consulting Engineers, R. Libero Badaro 152,10°, São Paulo, Brazil.

Rewkiewicz, Jacek, Naval Engineer, Soiltest, Inc., 4711 W. North Ave., Chicago 33, Ill. For mail: Pasteur 28, Ciudad Trujillo, Dominican Republic.

Suârez Carreño, Manuel A., Dean of Science and Technology, Villanueva University, Apartado 66, Marianao, Cuba.

Visman, Jan, Senior Scientific Officer, Canada, Department of Mines and Technical Surveys, 501 Public Bldg., Calgary, Alta., Canada.

* [J] denotes Junior members.

Bookshelf

(Continued from page 57)

Specifications for Paints

Steel Structures Painting Council, 4400 Fifth Ave., Pittsburgh 13, Pa., 96 pp., $1.50.

THE Paint Specifications outline composition and performance requirements for paints and coatings that will result in satisfactory performance on steel structures in various services and exposures. All have proved of outstanding ability and performance in actual use. Most of the materials have been developed by some independent company or agency and are currently in use, but their specifications cannot be procured by the average interested party. The Council does not aim to duplicate already existing specifications which are available and for that reason, has revised only specifications that are not available and reissued them along with its own.

The twenty paint specifications include 12 primers for structural steel, a cold-applied asphalt mastic coating, and 13 intermediate and finish coat paints. Oil base, phenolic, alkyd, and vinyl paints are included.

The specifications are published in a booklet of 96 pages, 8½ by 11 in., and may be purchased from the Council for $1.50.

• • •

Steel Structures Painting Manual Vol. 2—Systems and Specifications

Steel Structures Painting Council, 4400 Fifth Ave., Pittsburgh, Pa., 300 pp., $6.

VOLUME 2, edited by Joseph Bigos, Director of Research, Steel Structures Painting Council, contains specific recommendations on painting a great variety of steel structures and surfaces in various exposures.

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(Continued on page 78)

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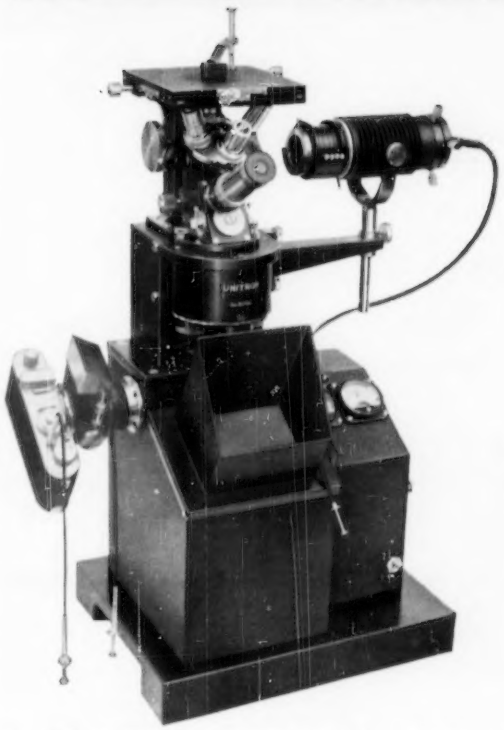

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Note—This information is based on literature and statements from apparatus manufactures and laboratory supply houses

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Beckman Div., Beckman Instruments, Inc., Fullerton, Calif.

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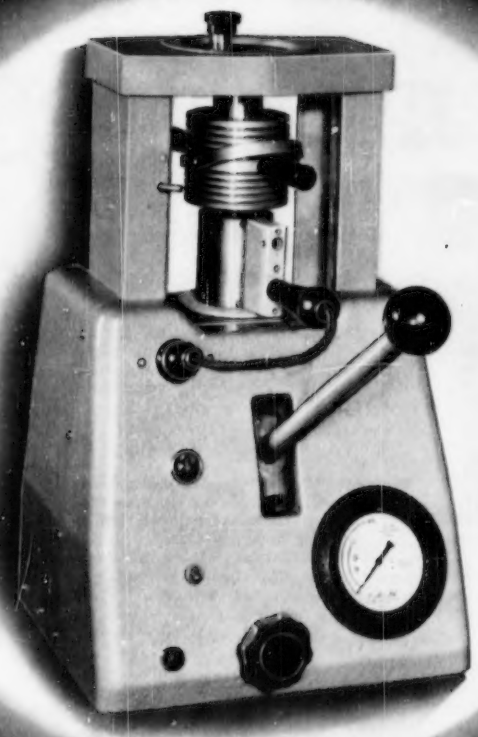
(Continued on page 74)



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(Continued from page 72)

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(Continued on page 75)

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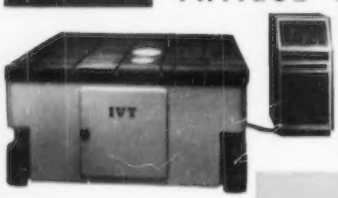

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(Continued from page 74)

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Platinum Sensing Element—Platinum resistance temperature detectors that are small and have high speed response for use in precision temperature measuring and control systems.
Fielden Instrument Div., Robertshaw-Fulton Controls Co., 2920 N. 4th St., Philadelphia 33, Pa.

Electronic Scanning—Checking and controlling various steps in production processes now are greatly simplified through use of a recently developed electronic scanning instrument.
Fielden Instrument Div., Robertshaw-Fulton Controls Co., 2920 N. 4th St. Philadelphia 33, Pa.

Water Monitor—Designed specifically for continuously monitoring the characteristic radiation spectrum of effluent coolant water from a reactor.
Radiation Counter Laboratories, Inc., 5122 W. Grove St., Skokie, Ill.

Bench Micrometer—Designed with non-rotating spindle it provides an excellent aid for fine small-parts-measurements such as instruments, parts, and wires.
George Scheer Co., Inc., 200 Lafayette St., New York 12, N. Y.

Tension Test Specimens—Tension test specimens conforming to ASTM specifications can be accurately machined from both ferrous and non-ferrous (0.002 in. to 0.125 in.) sheet metal in less than three min.
Sieburg Industries, Horse Plain Road, New Britain, Conn.

Deflection—A simple and an accurate device for measuring the deflection of flexible pavements under the action of moving wheel loads.
Soiltest, Inc., 4711 W. North Ave., Chicago 39, Ill.

CATALOGS AND LITERATURE

Molykote—*Bulletin 161* describes in detail a general purpose grease with extreme bearing pressure properties.
Alpha Molykote Corp., 65 Harvard Ave., Stamford, Conn.

Plastics—A new condensed catalog of plastic welding and spraying equipment,

(Continued on page 76)

How REVERE saves money, metal and time with SPERRY REFLECTOSCOPES

Operator probes 8-in. diameter, 7- to 8-ft. round aluminum ingots from end and along axis for flaws. Test is simple, fast and accurate; keeps step with high-speed production; saves metal, money and time.

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(Continued from page 75)

large plastic moldings, weldments, and component parts for welded fabrications.
American Agile Corp., P. O. Box 168, Bedford, Ohio.

Strain-Gage Calibrator—A device for the precise calibration of strain gages, load cells, proving rings, and similar measuring devices measures total loads to 200,000 lb. *Bulletin 4063.*
American Instrument Co., Inc., Silver Spring, Md.

Spectrometer—*Bulletin No. 44* provides a detailed description of improved models, direct reading spectrometers featuring the automatic servo monitor.
Baird Associates, Inc., 33 University Road, Cambridge 38, Mass.

Infrared—Availability of custom designed semi-conductor lenses for infrared application is described in *Technical Circular No. RD 516.*
Baird Associates, Inc., 33 University Road, Cambridge 38, Mass.

Pyrometer Users—*Bulletin F 7259* gives service tips for pyrometer users.
Barber Colman Co., Rockford, Ill.

Vapor-Temp—*Bulletin No. 5525* illustrates a new low cost annular mechanical convection controlled relative humidity chamber known as Vapor-Temp.
Blue M Electric Co., 138th & Chatham St., Blue Island, Ill.

New Instruments—*Bulletin No. 330* presents a new line of rheometers, process units, gelometers, and auxiliary equipment, designed to meet the demand for better processing and control of the many dispersions, polymers, and lubricants now being used by industry.
Burrell Corp., 2223 Fifth Ave., Pittsburgh 19, Pa.

Drafting—A complete reference guide to domestic and imported drawing instruments and drafting supplies.
Compass Instrument & Optical Co., Inc., 104 E. 25th St., New York 10, N. Y.

Four-Channel Bridge Balance—An essential accessory for use in direct recording of the output of a wide variety of strain gages and strain-gage-type pickups without the use of amplifiers. *Bulletin CEC-1560.*
Consolidated Engineering Corp., 300 N. Sierra Madre Villa, Pasadena 15, Calif.

Micabond—*Catalog M-55* on bonded mica insulation.
Continental-Diamond Fibre Div., The Budd Co., Inc., Newark, Del.

Plug-In Units—New 40-page illustrated *Catalog 827* presents circuit drawings and specifications on 36 different EECO plug-in units for the design, development, and production of electronic equipment.
Electronic Engineering Co., of California, 180 S. Alvarado St., Los Angeles 57, Calif.

Glassware Washer—New mobile laboratory glassware washer, reducing labor costs and eliminating glassware breakage. *Bulletin No. 9100.*
Labline, Inc., 3070 W. Grand Ave., Chicago 22, Ill.

Corrosion—A new Corrosion Test Humidity Cabinet to test effectiveness of corrosion preventive materials. *Bulletin 3910.*
Labline, Inc., 3070 W. Grand Ave., Chicago 22, Ill.

Industrial Waste Treatment—A new *Process Data Sheet 700(2)* outlines latest developments for control of pH and redox in industrial waste treatment processes.
Leeds & Northrup Co., 4934 Stenton Ave., Philadelphia 44, Pa.

Ball Bearings—Catalog lists more than 500 different types and sizes of miniature ball bearings.
Miniature Precision Bearings, Inc., Keene, N. H.

Water Control in Cement Manufacture—New Bendix Nuclear Density Gage with ElectroniK Controller continuously controls water percentage—assures uniform product and fuel savings. *Instrumentation Data Sheet No. 1.1-4.*
Industrial Div., Minneapolis-Honeywell Regulator Co., Philadelphia 44, Pa.

Recording Microphotometer—Versatile laboratory analyzer plus ElectroniK Recorder enables continuous investigation of wide range of film patterns. *Instrumentation Data Sheet No. 10.16-20.*
Industrial Div., Minneapolis-Honeywell Regulator Co., Philadelphia 44, Pa.

Thickness Measurements of Moving Sheet Materials—Tracerlab Beta Gages with Brown ElectroniK Instruments used for continuous measurement of thickness or weight per unit area. *Instrumentation Data Sheet No. 10.9-1a.*
Industrial Div., Minneapolis-Honeywell Regulator Co., Philadelphia 44, Pa.

Radiation Detector—A new high-speed radiation detector five times faster than existing models responds to 98 per cent of any temperature change in less than a half-second. *Bulletin 9320.*
Industrial Div., Minneapolis-Honeywell Regulator Co., Philadelphia 44, Pa.

Magnetic Null Indicator—Two-page bulletin describing the Magnetik Null Indicator, a portable temperature-measuring instrument.
Docleam Div., Minneapolis-Honeywell Regulator Co., 1400 Soldiers Field Rd., Boston 35, Mass.

Constant Temperature Circulating System—*Bulletin 660* on the redesigned "Temp-Trol," a constant temperature circulating system used for heating or cooling refractometers and other instruments.
Precision Scientific Co., 3737 W. Cortland St., Chicago 47, Ill.

Ful-Kontrol Heater—*Bulletin 626* on redesigned "Ful-Kontrol" Heater, a wide-range laboratory heater with a built-in auto-transformer.
Precision Scientific Co., 3737 W. Cortland St., Chicago 47, Ill.

Laboratory Heater—*Bulletin 627*, a laboratory heater with built-in rheostat.
Precision Scientific Co., 3737 W. Cortland St., Chicago 47, Ill.

Metal Flexible Hose—Use and application data on flexible metal hose products are offered in *Universal Catalog U-333.*
Universal Metal Hose Co., 2133 S. Kedzie Ave., Chicago 23, Ill.

(Continued on page 78)

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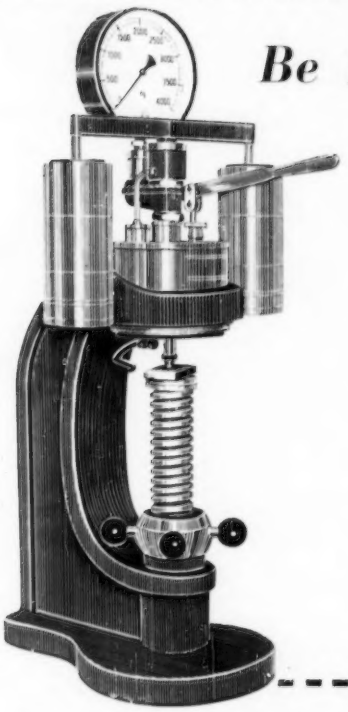

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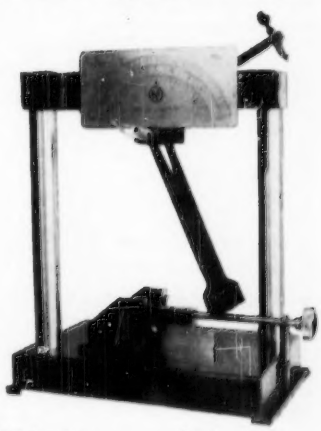

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Lab News

(Continued from page 76)

Magnascope—The Victor Magnascope V200, an instrument to project micro slides.

Victor Animatograph Corp., Davenport, Iowa.

INSTRUMENT COMPANY NEWS

Brush Electronics Co., Cleveland, Ohio—The promotion of David B. Parkinson and John H. Harris to Vice-Presidencies of the Brush Electronics Co. was announced by Douglas C. Lynch, President of Brush.

Varian Associates, Palo Alto, Calif.—To keep up with increasing demand for its scientific products and engineering services Varian Associates, electronic firm, has started a major enlargement of its Palo Alto plant.

NEWS OF LABORATORIES

Sam Tour & Co., Inc., New York, N. Y.—The new Director of the Chemical Department at Sam Tour & Co., Inc., is Samuel T. Page.

Books

(Continued from page 71)

dexes of recommended maintenance painting schemes, Volume 2 includes specifications for surface preparation, pretreatment, paint application, paints, and paint systems. This makes it possible to specify the painting of a steel structure in the same easy precise method as steel itself is specified—by reference to a specification number.

Volume 1—Good Painting Practice—is an encyclopedia of detailed information on all phases of cleaning and painting steel structures. In both volumes existing ASTM specifications which pertain to steel structures maintenance problems are fully utilized and referenced.

• • •

Proceedings—Standards Engineers Society

Standards Engineers Society, P.O. Box 281, Camden 1, N. J., 48 pp., $3.

COOPERATION of Government and industry in work on standards was the theme of the 1954 meeting of the SES.

Included in the Proceedings are the following: An Adventure in Cooperation (Integration of Government and Industry Standards) by R. V. Vittucci; The Integration of Military and Industry Standards, by S. H. Watson; The Important Problem of Integrating Industry and Government Standards, by ASTM Executive Secretary R. J. Painter; International Standardization and American Industry, by Howard Coonley; Place of Standardization in Management, by H. Thomas Hallowell, Jr.; and How to Set Up and Operate a Materials Department, by M. A. Williamson.

Properties of Glass

2nd Ed., George W. Morey, ACS Monograph No. 124, Reinhold Publishing Corp., New York, N. Y.; 1954; 591 pp.; $16.50.

CERTAINLY one of the most significant events in the ceramic industry in recent months has been the publication of the revision of Morey's *Properties of Glass*. This work has long stood as one of the most important texts in the ceramic field for both students and technologists.

The new edition includes summaries of the massive amount of research work published since 1938. It contains new sections on nonsilicate glasses and the effects of radiation on glass. The problem of the constitution of glass is considerately handled with due attention being paid to past as well as the present status of knowledge of glass structure.

This second edition, with its mass of data, hundreds of references, and even broader scope will again prove to be a primary source of information to all the field of glass.

• • •

Fire Hazards of the Plastics Industry

70 pp., National Board of Fire Underwriters, 85 John St., New York 38; paper bound.

THIS publication, a revision of an earlier report issued in 1946, provides useful information to the insurance official, public authorities, and fire protection engineers regarding the composition and classification of plastics as well as methods of manufacture and fabrication of products. Also provided for key operating and plant safety personnel is a discussion of fire and explosion problems associated not only with the manufacture of basic resins but with the hazards associated with fabrication and use of plastics products. Organizations contributing information and assistance included the Underwriters Laboratories, various agencies of the Government such as the Bureau of Mines and the Bureau of Standards, The National Fire Protection Assn., The Society of the Plastics Industry, The Manufacturing Chemists Assn., and ASTM Committee D-20 on Plastics.

Chapter headings are as follows:

I. Introduction
II. Plastics—Their Composition and Classification
III. Production of Industrial Plastics
IV. Hazards of the Plastics Industry
V. Flammability and Thermal Stability of Plastics
VI. Fire Safety Program for the Plastics Industry

Of particular interest are the ASTM contributions included in Chapter V in which ASTM test methods are cited as the means for characterizing plastics according to their thermal and flammability properties.

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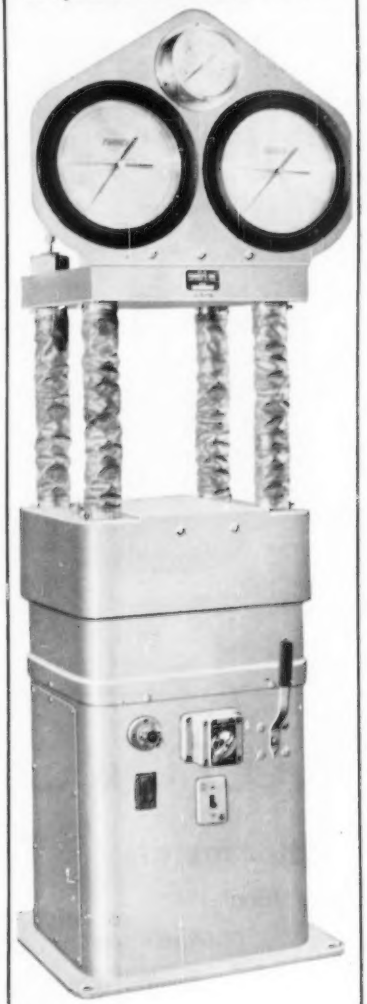

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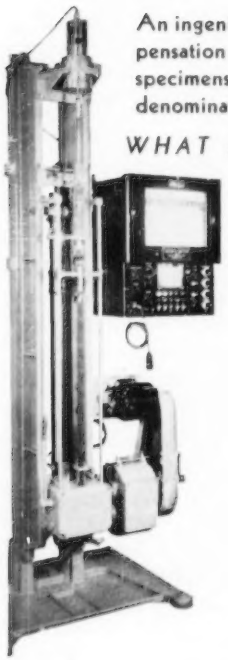

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The picture is one of the illustrations in a recent Machine Design *article, "High Speed Photography in Product Development," by W. G. Hyzer. This article is so clear and encouraging that a man who sends for a free reprint to Eastman Kodak Company, Graphic Reproduction Division, Rochester 4, N. Y., may wind up buying a* Kodak High Speed Camera.

5-Nitroso-oxine on the spot

5-Nitroso-8-quinolinol has been tried and found wanting as a chelating reagent for metals. Unnitrosated *8-Quinolinol*, better known as "oxine" or Eastman 794, has been long known as an effective metal precipitant but notoriously non-specific. The nitrosation succeeds in preventing precipitation of Al, Ga, In, and Mg but also removes the assurance of quantitative precipitation of the commoner metals. You can read all about it in a richly learned but discouraged paper appearing in *The Analyst* for April '55.

Still we do not despair of selling our *5-Nitroso-8-quinolinol* (Eastman 7097), for on page 133, Volume II, of Feigl's great "Qualitative Analysis by Spot Tests" (4th edition) it says that if one drop of a 1% solution of this compound in concentrated sulfuric acid is dropped onto a dried drop of alkaline test solution and then gently warmed, the following quantities of phenols reveal themselves by forming indophenols of the following hues:

dark brown: 1γ phenol
red-violet: 2γ resorcinol
black: 7γ pyrogallol
greenish-black: 4γ pyrocatechol
green-yellow: 5γ o-nitrophenol
dark brown: 5γ o-cresol
violet: 5γ xylenol
dark brown: 10γ α-naphthol
(1γ = 1 microgram)

This is typical Feigl analysis—exquisite, low-budget, and compact enough to be worked in a phone booth.

We hope everybody buys the book from Elsevier Press, Inc. (2330 Holcombe Blvd., Houston 25, Texas) and the reagents from our stock of some 3500 organic chemicals. Distillation Products Industries, Eastman Organic Chemicals Department, Rochester 3, N. Y. (Division of Eastman Kodak Company).

The soft x-ray

Because so many professional opinions on periodontoses, pelves, porosities, and the like are reached from observations on our x-ray film, we find ourselves with the resources to do little things for our friends, who are legion.

For example, a bibliography on soft x-ray microscopy, microradiography, electron radiography, and geometric x-ray microscopy.* It lists every paper and article on those subjects known to us, except that unlike our bibliographies of vitamin E, this is not annotated. The arrangement is alphabetical by authors, whether they be of the industrial, medical, metallurgical, botanical, zoological, entomological, or fine arts persuasions or just plain physicists.

The earliest reference was published April 13, 1896, in *Comptes rendus hebdomadaires des séances de l'Académie des sciences* by F. Ranwez under the title, "Application de la photographie par les rayons Röntgen aux recherches analytiques des matières végétales." The most recent is dated August, 1955, and deals with electron radiography in the investigation of postage stamps. Among the 350-odd items that lie between these two, you will find "Ueber Weichstrahlaufnahmen mit der Gleichspannungsmaschine 'Trifas' der Elektrizitätsgesellschaft 'Sanitas'" (H. Chantraine, *Fortschritte auf dem Gebiete der Röntgenstrahlen vereinigt mit Röntgenpraxis, 38:* 534-541, September, 1928) and "Микрорентгенография" (С. В. Гречишкин, *Вестник рентгенологии и радиологии, 20:* 397-408, 1938).

Sending out free copies of the microradiography bibliography is easy for Eastman Kodak Company, X-ray Division, Rochester 4, N. Y. We'll go beyond that. If you'll give us the details of your problem, we'll do our best to answer questions about the use, handling, and behavior of sensitized materials in experimental radiographic work. But you wouldn't want us to do your research for you, would you?

*For the casual reader:

Soft x-rays are those of wavelength longer than about 0.25 Å. They are so easily absorbed that exceedingly thin or low-density materials, quite transparent to the ordinary x-rays of the healing arts, cast informative shadows. If the shadows are of microscopic details, if they are caught on very fine-grain film in close contact with the specimen, and if this film image is greatly enlarged in printing, that is *microradiography*. A switch in this technique is to use hard x-rays (wavelength shorter than 0.050 Å) that can knock electrons out of a sheet of lead and let differences in absorption of the electrons by the various parts of the specimen tell the story on film. This is *electron radiography*. Still another way of doing x-ray microscopy is to use a very tiny but intense x-ray source and keep it so close to the specimen that it casts greatly enlarged sharp x-ray shadows on the film, which can then be even further enlarged in projection printing. This is *geometric x-ray microscopy*.

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OTHER SOCIETIES' EVENTS

November 1-3—**Investment Castings Institute,** Fall Meeting, Sheraton-Cadillac Hotel, Detroit, Mich.

November 1-5—**Association for Applied Solar Energy,** Westward Ho! Hotel, Phoenix, Ariz.

November 2-4—**SAE National Meeting,** Diesel Engine Meeting, The Chase, St. Louis, Mo.

November 2-4—**Society of Rheology,** Annual Meeting, New York City.

November 2-4—**ACS Div. of Rubber Chemistry,** 68th Mtg., Bellevue Stratford Hotel, Philadelphia, Pa.

November 3-4—**Fourth Annual Instrumentation Conference,** Louisiana Tech., Ruston, La.

November 3-4—**Society for Advancement of Management,** Eleventh Annual Conference, Statler Hotel, New York City.

November 7-8—**Forest Products Research Soc.,** Peabody Hotel, Memphis, Tenn.

November 8-11—**American Council of Independent Labs., Inc.,** Annual Meeting, Westward Ho! Hotel, Phoenix, Ariz.

November 9-10—**SAE National Meeting,** Fuels and Lubricants Meeting, The Bellevue Stratford, Philadelphia, Pa.

November 9-12—**Society of Naval Architects & Marine Engrs.,** 63rd Annual Meeting, Waldorf Astoria, New York City.

November 13-18—**American Society of Mechanical Engineers,** 75th Anniversary Meeting, Congress & Hilton Hotels, Chicago, Ill.

November 13-18—**American Rocket Society,** Annual Meeting, Congress-Hilton & Blackstone, Chicago, Ill.

November 14-17—**American Petroleum Institute,** 35th Annual Meeting, San Francisco, Calif.

November 14-17—**Second International Automation Exposition,** Chicago Navy Pier, Chicago, Ill.

November 14-18—**American Public Health Assn.,** 83rd Annual Meeting, Municipal Auditorium, Kansas City, Mo.

November 15-17—**American Meteorological Society,** 141st Meeting, Honolulu, Hawaii.

November 16-18—**Soc. for Experimental Stress Analysis,** Annual Meeting, Hotel Sheraton, Chicago, Ill.

November 17-18—**Industrial Hygiene Foundation,** 19th Annual Meeting, Mellon Institute, Pittsburgh, Pa.

November 22—**Manufacturing Chemists' Assn.,** Semiannual Meeting, New York City.

November 25-26—**American Physical Society,** Chicago, Ill.

November 27-30—**American Institute of Chemical Engineers,** Annual Meeting, Statler Hotel, Detroit, Mich.

November 27-30—**American Chemical Society,** National Chemical Exposition, Cleveland, Ohio.

Dec. 1-3—**American Society of Refrigerating Engrs.,** 51st Annual Meeting, Traymore Hotel, Atlantic City, N. J.

December 4-7—**American Society of Agricultural Engineers,** Winter Meeting, Edgewater Beach Hotel, Chicago, Ill.

December 5-9—**25th Exposition of Chemical Industries,** Philadelphia, Pa.

December 12-17—**Nuclear Congress and Atomic Exposition,** (Coordinated by Engineers Joint Council), Cleveland, Ohio.

December 26-31—**American Assn. for the Advancement of Science,** Biltmore Hotel, Atlanta, Ga.

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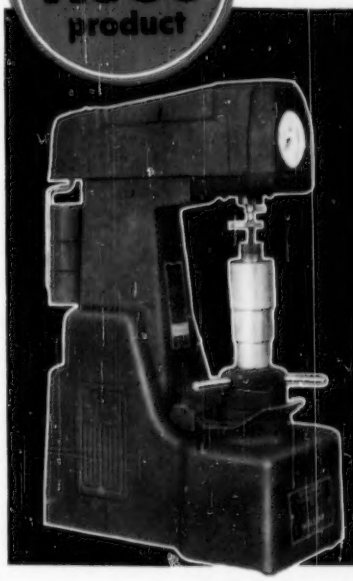

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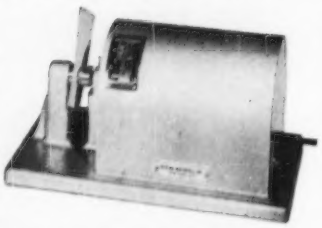

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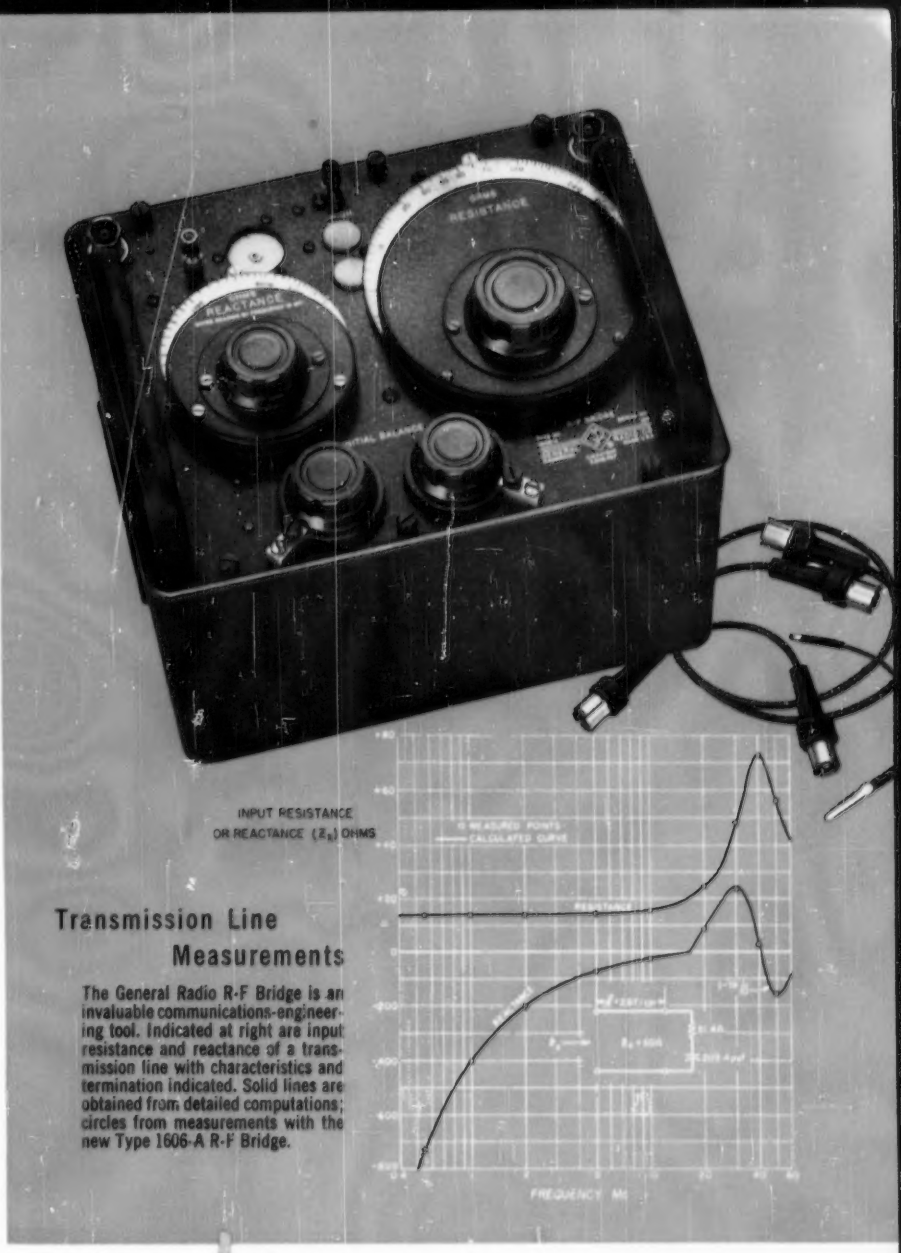

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